TAXONOMIC STUDIES ON

THE MOSS FLORA OF IRINGOLE KAVU

Dissertation submitted in partial fulfillment of the requirements for the award of the Degree of "Masters of Science" in

BOTANY

By

ATHIRA RAJENDRAN

REG. NO: AM23BOT002

DEPARTMENT OF BOTANY AND CENTRE FOR RESEARCH

ST. TERESA'S COLLEGE (AUTONOMOUS)

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This is to certify that the project work titled "**TAXONOMIC STUDIES ON THE MOSS FLORA OF IRINGOLE KAVU**" is an authentic record of work carried out by **Athira Rajendran (Reg. No:AM23BOT002)** under my supervision and guidance in the partial fulfillment of the requirement of the M.Sc. Degree of Mahatma Gandhi University, Kottayam. I, further certify that no part of the work embodied in this dissertation work has been submitted for the award of any other degree or diploma.

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Place : Ernakulam
Date : 05/05/2025

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DECLARATION

I hereby declare that the project work entitled "**TAXONOMIC STUDIES ON THE MOSS FLORA OF IRINGOLE KAVU**" submitted to Mahatma Gandhi University, Kottayam, in the partial fulfillment of the requirements for the award of the Degree of Master of Science in Botany is an authentic project work done by me under the supervision and guidance of Dr. Chandini V.K., Assistant Professor, Department of Botany and Centre for Research, St. Teresa's College (Autonomous), Ernakulam.

Athira Rajendran

Place: Ernakulam

Date: 05/05/2025

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Athira Rajendran

CONTENTS

INTRODUCTION

Bryophytes are simplest, primitive members usually inhabiting moist and shady areas representing the second largest group after Angiosperm. These plants lack true vascular tissues like xylem and phloem, which transport water and nutrients in higher plants. As a result, bryophytes are generally small, grow close to the ground, and are found in moist, shady environments where they can absorb water directly through their surface cells. Bryophytes can grow in terrestrial habitats, but water is essential for their sexual reproduction. So they are called as amphibians of plant kingdom. Bryophytes, including liverworts, hornworts, and mosses, are unique for their alternation of generations, featuring a dominant haploid gametophyte stage and a smaller, dependent diploid sporophyte stage. They play crucial roles in forest ecosystems by aiding nutrient cycling, water retention, soil formation, and providing shelter for microbes, while also serving as indicators of pollution.

Mosses are small, non-vascular plants that are part of the bryophyte group, which also includes liverworts and hornworts. These plants typically grow in dense green clusters or mats, often found in moist or shaded environments. Individual moss plants usually have simple leaves, generally one cell thick, attached to a stem that may be branched or unbranched. This stem plays a limited role in transporting water and nutrients. While some moss species possess conducting tissues, these are typically underdeveloped and structurally different from those in vascular plants. Mosses reproduce via spores, developing sporophytes with unbranched stalks and single capsules at the top after fertilization. They are generally between 0.2–10 cm (0.1–3.9 in) in height, though some species can be much larger; for example, *Dawsonia*, the tallest moss, can reach up to 50 cm (20 in). It's common to mistake mosses for liverworts, hornworts, and lichens. Although often classified as non-vascular, many mosses have more developed vascular systems. Similar to liverworts and hornworts, the dominant phase in the moss life cycle is the haploid gametophyte generation, unlike vascular plants where the diploid sporophyte generation is dominant.
Commercially, mosses are primarily important as the main component of peat (mainly from the *Sphagnum* genus). They also have decorative uses in gardens and the florist trade. Traditionally, mosses were used for insulation and due to their high liquid absorption capacity, being able to absorb up to 20 times their weight in liquids.

Sacred groves are patches of forests or other natural vegetation that are protected by local communities due to their religious or cultural significance. These groves are often associated with

a deity, ancestral spirits, or other religious beliefs, which makes them highly revered and conserved. Sacred groves are considered biodiversity-rich areas. They are often home to rare and endemic species of plants, animals, and fungi that may not be found in surrounding areas. Some groves act as miniature ecosystems that have remained undisturbed for centuries, serving as refuges for species that are extinct or endangered in other regions. In many cases, human activities like tree cutting, hunting, or even entering the groves are restricted.

India, with its rich cultural diversity and strong traditional connection to nature, is home to thousands of sacred groves. These groves, spread across various ecological zones, are crucial for ecological, spiritual, and cultural reasons. They are found across the country, particularly in states like Kerala, Maharashtra, Himachal Pradesh, and the northeastern regions. However, in recent years, there has been increasing pressure on sacred groves due to factors such as population growth and economic development. This has led to the degradation of some sacred groves and the loss of their biodiversity. Sacred groves are confined to low altitude unlike in other neighbouring districts like Kottayam or Thrissur, the number of sacred groves in existence as well as its extent is a matter to be analysed with respect to the cultural background of Ernakulam. The total number of Sacred Groves in the district is 708, of which the largest one in the district, the famous Iringole Kavu (25 Acres) Perumbavoor. It is a forest temple dedicated to the Goddess Durga. It is believed that the gods and goddesses surrounded the power in the forms of trees and plants. Thus, the area developed into a beautiful thick forest. None of the Sacred Groves in Kerala support such a thick evergreen luxuriant vegetation.

However, the diversity of bryophytes in India is not well documented, and sacred groves, with their unique microclimates and undisturbed habitats, may harbor many undocumented species. Numerous floristic studies have been conducted in various sacred groves, primarily focusing on angiosperms and higher plant groups. However, there is limited research on lower groups, particularly bryophytes.

OBJECTIVES

- A comprehensive field study for the collection of Mosses from Iringole kavu sacred grove
- Preparation of taxonomic account of the Bryophytes collected from the study area along with critical notes.
- To provide an explanation of the morphological and anatomical characteristics of every species found.
- Photographic documentation of all the species.
- To compile an herbarium of bryophytes sourced from Iringole Kavu for future reference, as deposited in DSAH, St. Teresa's College and enrich the herbarium collection of bryophytes.

STUDY AREA

A densely grown miniature forest in the middle of fast-developing urban jungle encircled with myths, beliefs and mysteries – this is 'Iringole Kavu' sacred grove. Here sunlight is unfathomable even in hot summers. This temple is situated in the village 'Pattal' 40.8 kilometers from Kochi, 3.4 kilometres from Perumbavoor, and 18 kilometres from Kothamangalam.

Iringole Kavu is a forest temple of Goddess Durga located in Kunnathunad Taluk of Ernakulam district, 3.4 km from Perumbavoor (Plate 1). This is one of the 108 Durga Temples in Kerala said to have been consecrated by Lord Parasurama, the sixth incarnation of Lord Vishnu. The Goddess [Incarnation of Yaga-Nidra (Maya)] is in her original three forms of power: Morning - in the form of Saraswati (The power of knowledge) Noon - as Vana Durga (Power of forest) Night - as Bhadrakali (Power of fury and destruction (of evil)).

The overall area of the 'Kavu' is approximately 50 acres and is located at 10°6'31″N/ 76°30'2″E. The forest temple was previously owned by 28 illoms (habitation of Brahmins). There is no particular data on the year of its origin for Iringole temple. Astrological computation, in 1986 revealed that the temple was 2746 years old at that time. But the religious rituals, offerings and visits of the devotees started only 1200 years ago. The temple's history is rooted in a mythical mythology. In Dwaparayuga, Kamsa, the king of demons arrested Devaki and Vasudevar out of the fear that their eighth son Krishna to be born shortly would be his destroyer from the earth. Out of fear and anger Kamsa resolved to murder all their sons. Vasudevar designed to rescue his eighth son out of the risk at any expense. The parents relocated baby Krishna to Vrindavan after his birth and kept another baby girl (a reincarnation of the goddess Yoga-Nidra or Maya) in the cradle. Kamsa resolved to eliminate the baby girl as well, even after recognizing she wasn't the eighth son of Vasudevar. He raised the baby angrily on top of his head, but wonderfully the baby transformed into an supernatural force and hovered in the air as 'IRRINNOLE'. Later the place was known as IRINGOLE. There are opinions that the gods and goddesses engulfed the strength in the pattern of trees and plants. And subsequently, it is grown into a thick beautiful forest. The grand fest (pooram) of the temple occurs between second to tenth of the Malayalam month of Meenam (around March to April).

This festival is also a joy to see when the entire forest is illuminated and decorated. Unlike other temples, only female elephants take part here for the pooram. The locals around the sacred grove regard the trees within the forest as different gods. Because of this reason the area is properly

guarded and not even a single stick is uprooted out of the grove. A temple trust member claimed that it used to be a thick forest compared to what it is today and even sunlight did not reach the ground. However, in 1993, several large trees collapsed following a storm. Iringol kavu was in the possession of and controlled by 28 families. But of these 28 families 25 families departed leaving behind only three families of Iringole (Naganchery, Pattasheri, and Orozhiam) as owners until kavu and forest around it came under Travancore Devaswam Board.

Keeping in mind the ecological significance, the Kerala Biodiversity Board had identified Iringole Kavu as one among the five biodiversity heritage sites in the state

There are three primary routes and some minor routes that lead to the central temple. But all the routes end at a common point. And also the forest has no perilous animals, so the visitors need not be afraid of their safety within the forest. The 50 acres of this Western Ghats forestland harbors animals, birds and plants of the Western Ghats which are listed as endangered Some studies. According to that stretch has some rare woods such as the 'Kambakam' or Malabar Iron wood, white pine, wild jack (Anjili) teak etc. and drugs such as wild pepper and long pepper. There are 44 bird species in this forest comprising parrots, cuckoos and eagles. The grove is also observed in various shades of green even in intense summers. This is due to the fact that there are numerous macrohabits (Plate 2). The 'theerthakulam' or temple pond within the grove is also green throughout the year.

Few studies explored the floristic diversity estimation of the Kavu, and discovered that there are a total of 142 plants and out of them 129 angiosperms, two gymnosperms, seven pteridophytes and four fungi are reported. Angiosperms comprise of 36 herbs, 23 shrubs, 41 trees and 29 climbers. Fabaceae, Rubiaceae, Moraceae, Acanthaceae and Apocynaceae are the dominant (Thomas *et.al*. 2023). However, a study on Bryophytes has not yet been attempted, making the study of these floristic elements a necessary contribution and significantly contribute to a more complete inventory of the Kavu’s plant life."

The temple itself is famous for its sheer beauty, harmoniously fitting into the landscape. Its sacred and peaceful vibe makes one pause and reflect, and it ranks among the prettiest temples in Kerala. The dense forest, coupled with the temple's spiritual energy, provides an extraterrestrial background that fascinates everyone.

REVIEW OF LITERATURE

Mosses

The golden era of Bryophytes is considered as 19th century, various aspects like Checklist of flora preparation, general documentation of Bryophytes and various phytochemical analysis of this groups also analysed by several researchers. Compared to the Himalayan and other regions of the country, Western Ghats of Southern India largely remain understudied.

Nair and Madhusoodanan (2001) conducted an initial investigation for bryophytes in the Eravikulam National Park, finding 19 species, including mosses and liverworts, six of which were new to Kerala. *Ricciocarpus natans* (L.) corda and *Notothylas levieri* Schiffn ex. Steph of Kerala Western Ghats were recorded by Madhusoodhanan and Nair (2003) as new South Indian records. *Frullania riojaneirensis* Raddi was initially discovered in India in the Gudalur district of the Nilgiri Hills, according to Srivastava and Alam (2004). *Bryum tuberosm* Mohamed & Damanhuri was reported by Nair *et. al.* (2004) as a new record from the plains of Uduppi in Karnataka. Nair and Madhusoodanan (2004) provide an overview of the diversity of Kerala's bryophytes, including a brief history, significance, and conservation considerations.

Bryophytes of Wayanad in Western Ghats', the first thorough taxonomic treatment of South Indian bryophytes, was published by Nair *et. al.* (2005). This includes taxonomic accounts of 171 species and two variations from 47 families and 105 genera, including two new species: *Amphidium gangulii* Manju *et. al.* and *Trichostomum wayanadense* Manju *et. al.* Numerous of these were novel distribution records with important phytogeographical implications.

Jungermannia obliquifolia (Schiffn.) Vana, a new record for India, was described by Manju *et. al.* (2009) from the Wet Evergreen forests of Aralam Wildlife Sanctuary in the Kannur district of Kerala state. An endemic species of Jungermaniaceae viz., *Notoscypus pandei* Udar & Ad. Kumar is reported by Manju *et. al.* (2009) from the Western Ghats of Kerala state. Manju *et. al.* (2011) offer a checklist of the bryophyte flora in the Parambikkulam Tiger reserve in the Western Ghats. The report includes 58 taxa, 39 mosses, one hornwort, and 18 liverworts, of which *Thuidium subdelicatulum* and *Grimmia funalis* (Schwägr.) Bruch & Schimp. have been reported as new records for India (Manju & Rajesh 2011). For the first time, three pleurocarpic mosses were identified from Peninsular India: *Pelekium gratum*, *Fabronia schensiana* and *Calyptothecium wightii* (Mitt.) M. Fleisch. (Nair *et. al.*,2007). 40 species of bryophytes, including 24 mosses and 16 liverworts, were described in a study of the Kakkavayal Reserve forest in the

Western Ghats. Cololejeunea appressa (Evans) Benedix, C. follicola Srivastava & Srivastava, C. udarii Asthana & Srivastava, and Pallavicinia himalayensis Schiffn are four new records of phytogeographical relevance to Kerala.

Several species of Calymperaceae were reported from India ; 5 genera are recognised within the family viz., *Calymperes* Sw., *Exostratum* L. T. Ellis, *Leucophanes* Brid., *Octoblepharum* Hedw. and *Syrrhopodon* Schwägr. (Nair *et. al.*, 2020). Bryofloristic studies especially mosses have progressed in Kerala state (Manju *et. al.* 2008-2020; Daniels *et. al.* 2011; Mufeed *et. al.* 2021), exploring the protected areas of Kerala, including Wildlife Sanctuaries, National Parks, and Tiger Reserves.

Bryophytes were primarily found in the face and base of concrete walls, the top, face, and base of stone walls, and the top of brick walls emphazising species diversity and microhabitat features on of bryophyte richness (Duan & Wang, 2023) based on their research

Sacred Groves

Early studies on sacred groves in India highlighted their diverse nomenclature and cultural significance. Chandran & Gadgil (1993) and Chandran & Hughes (1997) noted that in Kerala, these sites are often called Kavu and serve as places of worship. Chandrashekara & Sankar (1998) expanded on this, documenting various names for sacred groves across different states, including Sarnas in Bihar, Dev in Madhya Pradesh, and SarpaKavu or Kavu in Tamil Nadu and parts of Kerala. Gokhale (2004) and Chandrakanth *et. al.* (2004) & Khumbongmayum *et. al.*, (2004) specified the term Devarakadu in Karnataka and Lai umang in Manipur, with Chandrakanth *et. al.* (2004) also pointing out the role of government institutions in their management. . Sacred groves differ considerably in their sizes, ranging from small fields covering less than one hectare up to large areas extending over several hundred hectares (Malhotra *et. al.*, 2007). They are not only ecologically significant but also of great cultural importance to the local communities. Usually inextricably linked with the spiritual practices of the inhabitants, sacred groves are places of worship, where shrines form a part of communal rituals and ceremonies.

The ecological importance of these groves was emphasized by Bhagwat *et. al.* (2005) and Bhagwat & Rutte (2006), who, while acknowledging their small size, recognized their crucial role in biodiversity conservation. Malhotra *et. al.* (2007) further described their size range and dual ecological and cultural significance. Khan *et. al.* (2008) contributed to the understanding of how sacred groves function to maintain biodiversity. The management and conservation of sacred sites

gained attention from Nagendra & Gokhale (2008) and Wild & McLeod (2008), with the latter highlighting the involvement of international organizations like IUCN and UNESCO. Nagendra & Gokhale (2008) also discussed the historical context of forest control under British colonial rule. Kassilly & Tsingalia (2009) , Kassilly (2023), focused on the cultural importance of the Tiriki sacred forests in Western Kenya, while Kent (2009) provided a broader historical perspective, tracing the development of sacred groves in Europe and noting Dietrich Brandis's early recognition of them in India. Manju *et. al.* (2008) contributed to the Bryophyte record by reporting new species *Fissidens kammadensis* Manju, K.P. Rajesh & Madhus.and records of bryophytes from the Western Ghats. The challenges and opportunities associated with increased recognition of sacred groves, particularly concerning tourism, were examined by Schaaf & Rossler (2010). Further botanical studies continued to document the diversity within sacred groves. The presence of sacred groves in other cultural contexts was documented by Allendorf *et. al.* (2014) in Yunnan, China.

More recent research has continued to explore the biodiversity and ecological roles of sacred groves. In 2010, Singh *et. al.* conducted a thorough study of the Haat Kali sacred grove in the central Himalayas. Their careful survey listed a total of 42 species of angiosperms, in addition to 4 pteridophyte, 15 bryophyte, and 35 lichen species. Remarkably, of the bryophytes, *Macromitrium rigbyanum* Dixon was found to be an endemic moss, thus identifying the distinct biodiversity in this ecosystem. Chanda & Ramachandra (2019) submitted a comprehensive survey of 346 sacred groves from five different geographical regions of India and listed a whopping total of 1,740 plant species belonging to different groups. Their data showed that bryophytes were represented by 7 families and 7 genera, and mosses by 8 families and 8 genera, further highlighting the diversity which still remains to be exhaustively studied in these ecosystems. Building further on knowledge of bryophyte diversity of sacred groves, Jyothilakshmi *et. al.* (2016) made a detailed study at Vallikkattu Kavu in the Kozhikode district of Kerala ,when they recorded a total of 29 species of bryophytes. These comprised a rich mix of 10 liverworts and 19 moss species, demonstrating the wealth of variety present in these holy habitats. On the basis Ahmed *et. al.*, (2023) found that sacred groves provide a gene bank for the endemic and threatened flora and fauna diversity, which are either vanishing from the open forest areas are elsewhere some species get cleared but these are still present in good numbers in the sacred groves.

Sacred groves is a special ecosystem that contains diversity in fauna as well as flora. It works as an Island in the anthropocentric sphere; it can't be divorced from social and economic

circumstances. Bryophyte studies in sacred groves are relatively underrepresented compared to other plant groups. It might emphasize the need for more focused research to fully understand the diversity, distribution, ecological roles, and conservation status of bryophytes within these traditionally protected ecosystems. (Nishida *et. al.* 2020). Sacred grooves are varied owing to limited human activities due to some reverence and fear regarding the God/Goddess lurk in them. They are usually managed by various institutions, such as trustees and non-governmental organizations, which seek to conserve and protect these culturally important places. In some regions of the world, it's management may be in the hands of individual families or groups of related families, who take on the responsibility of maintaining these groves within their communities. The villagers also have the notion that the religious standing of the grove bestows spiritual fortification that protects the community and its people from catastrophe and calamity. Being intimate with these nature resources produces an obligation toward maintaining them as a mutual bond between the natural elements and people, so they not only persist to the coming generation but also have a cultural and spiritual reverence placed upon them within the community. Moreover, government institutions can be also engaged in managing temples so that the holy locations are well looked after and cherished (Chandrakanth *et. al.*, 2004).

In the rural areas, the management of sacred groves is usually assigned to the village head, whose role is of great importance when it comes to maintaining the native traditions and law governing these territories. As a protector, the village head shall have the duty of overseeing activities within and around the grove and of ensuring that citizens obey rules drawn up to safeguard such sacred places. Should any violation of such rules be found, the village head can sanction punishment or penalty on the resident violator, emphasizing the need to respect the sacred character of the grove and for communal peace. This system of government is essential for the conservation of the cultural heritage and ecological integrity of sacred groves in the community. According to Plieninger *et. al.* (2020). These groves usually represent critical cultural symbols, retaining long-standing traditions and ensuring that communities remain deeply rooted with their surroundings.

Recently, Neethu & Sreeja (2020) recorded 18 bryophyte species from two sacred groves, Madayikavu and Konginichalkavu, in Kannur district. Their record included 8 liverworts, 2 hornworts, and 8 mosses, adding to the expanding body of data available for these key but not well-studied plant groups.

Dhyani *et. al.*, (2024) conducted a thorough investigation of the diversity of the mosses of an unexplored and unusual geographical area of Himalaya, namely the Pangi valley in the state of Himachal Pradesh, India has been explored. A record of 49 moss species within 21 families have been obtained including Hedwigia emodica, about the type specimen detail of which nothing is known, and *Encalypta vulgaris*, which is a Himalayan rare species of moss. Benítez *et. al.*, (2025) stated that epiphytic bryophytes constitute a crucial part in relation to the diversity and ecosystem function of montane forests that are called biodiversity hotspots. Bryophytes are sensitive to external environment changes due to disturbance, fragmentation, air pollution, and climate change, for which they rely heavily on the external environments.

The results of these different studies imply a pressing necessity for more comprehensive research on bryophytes in sacred groves, both in India and internationally, since existing literature shows that studies are restricted to just a few studies. The documentation of a new and distinctive moss species from a Kerala sacred grove highlights the unexploited potential for the identification of other bryophyte species. Further observation and overall research into bryophyte diversity in sacred groves will surely yield important ecological information and add to our knowledge of these crucial ecosystems.

MATERIALS AND METHODS

Collection

The foundation of taxonomic research relies on systemic collection. Examining a small area carefully yields more results than traveling to different locations since the species is found in particular spots. Due to their small size and fragile nature, these plants were handled with extreme care. Plants were scraped out from the substratum with the help of a sharp edged knife. The bulk of the soil attached to the material was removed, leaving a thin layer attached. Two or more species may grow together, hence were collected together by giving same field number and separated later into different packets assigning same number with serial numbers. The plants were dried keeping them in between the blotting papers or news papers. The field data including date, locality, altitude, family, habit, habitat, name of collector, notes etc. were also noted down. The name of genera/species and their associates were added after careful examination.

Preservation

Mosses were preserved as dried specimen in herbarium paper packets; paper packets are made by folding thick paper of standard size. The specimens stored in paper packets will remain viable for several days for examination purposes. Field data were also noted on these specimen packets.The materials kept in paper packets will remain fresh and alive for some days (they can regain its original shape and size, and to some extent colour also) so that it can be examined alive, which later may be dried and stored as Herbarium.

Investigation and identification

Fresh materials were subjected to study, whenever possible, for identification. External morphological features were studied under a stereo microscope (MicroAim) and internal features by a compound microscope (OLYMPUS 3X31). Specimens were soaked in distilled water for 5-10 minutes for getting the clear view of the cells. Size of leaves, cells and capsule were measured by micrometry. Identification of specimens was done by referring authentic literatures (Mufeed *et. al.*, 2021; Daniels, 2013; Gangulee, 1967-74; Nair *et. al.*, 2005; Singh & Nath, 2007, Glime, 2007). The specimens lodged at other herbarias such as Calicut University Herbarium (CALI) and Malabar Botanical Garden (MBG) were also referred. Photographs of the habitat were taken using Camera and microphotographs under the microscope were taken using digital camera (MAGNUS

Mips Usb With Colour Cmos Camera with Fluorescent Attachment 48MP FHD CAMERA V8 and S-eye Microscope camera).

Taxonomic description

Detailed descriptions were given for each genus and species whenever it is needed. Authors of plant names are abbreviated based on Brummit and Powell (1992) and tittles journals were based on taxonomic literature. The taxa are arranged according to the classification of Shaw and Goffinet (2000). All the genera and species under the family are arranged alphabetically. Each species is described with up to date nomenclature, brief description of available characters such as leaves, cells, capsule, etc. The citations are limited to the publications relevant to Indian context. Dichotomous keys have been provided for families, genera and species on the basis of reliable characters. Photographs of habit and habitat of each species were also provided as far a possible.

Data Analysis

Collect and analyze information on the diversity, spread, and abundance of mosses in the grove. Determine potential influences on their distribution and examine possible threats to their preservation.

RESULT

Order: DICRANALES

Family: FISSIDENTACEAE Schimp.

Plants yellowish-green, leaves distichous, vertically placed, equitant with a characteristic sheathing or vaginent lamina, complanate; capsule lateral or terminal, calyptra conical.

GENUS: Fissidens Hedw., Sp. Musc. 152.1801.

Plants yellowish-green, small to medium sized, simple or dimorphic, vertically placed, leaves distichous, differentiated into sheathing lamina, dorsal lamina, (behind the costa) and apical lamina (above the sheathing lamina); capsule terminal or lateral, erect to inclined, peristome single, spores spherical,smooth to lightly papillose.

Key to the species

1a. Leaves with bryoides type costa; peristome bryoides type or scariosus type……..……2

1b. Leaves with oblongifolius type or taxifolius type costa; peristome not bryoides or scariosus type……...……..…….……6

2a. Laminal cells smooth or papillose or mamillose…….……..…….3

2b. Laminal cells guttulate, …….....

3a.Prominent excurrent costa, limbidium absent…….…….…..F. pellucidus

3b.Costa percurrent or excurrent in short apiculus……..……4

4a. Leaves lanceolate, vaginant laminae reaching more than half or up to 2/3 of leaf length, closed or slightly open……. *F. hollianus*

4b. Leaves oblong, Vaginat lamina open…….…….5

5a. laminal cells 2-4 papillose ……...…… *F. walkeri*

5b.Laminal cells unipapilose……..…….*Fissidens sp. 2*

6a. Leaf Axillary nodules on stem present……7

6b. Leaf axillary nodules absent…….*Fissidens* sp. 1

7a.Laminal cells obscure, costa percurrent or ending a few cells below apex……..*F. crispulus* var *crispulus*.

7b. Laminal cell wall clear, costa shortly excurrent……..*F. crispulus* var *robinsonii*

Fissidens crispulus var. crispulus Brid., Musc. Rec. Supp 1. 4: 187. 1819

Plant light to dark greenish, usually unbranched; leaf tip curl when dry, multicellular rhizoids coloured, 6-10 long and 2-3 mm wide including leaves, 8- 11 pairs of leaves; stem brownish green, leaf lingulate, sheathing lamina closed, dorsal lamina base round, leaves alternate, lower leaf reduced or small; 1.2-1.5 mm long, tip acute, sheathing lamina reaches up to half of the length of apical lamina, leaf 0.37-0.39 mm wide; costa yellowish green, ends 2 or 3 cells below the tip, cells rounded or irregularly hexagonal, intercellular space present, limbidial cells absent, and it consists of leaf tip cells, middle cells, basal cells. (Plate 3).

Habitat: On land cuttings , bark of stem, on concrete wall and brown rock.

Specimens examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2055a, Chandini 2055a, Athira 2060*, 27/07/2024, *Athira 2082, Athira 2083, Athira 2087, Athira 2095.*

Distribution: India;(Andaman & Nicobar Island, Darjeeling, Khasia Hills, Upper Assam, Bihar, West Bengal, Orissa, Kerala, Tamil Nadu); East Nepal, Sri Lanka; Myanmar; Thailand; Philippines; Japan; China; Malaysia; Madagascar; Reunion; Singapore; Bioko; Cameroon; Central African Republic; Chad; Comoros; Democratic Republic of Congo; Equatorial Guinea; Eritrea; Ethiopia; Gabon; Ivory Coast; Kenya; Malawi; Mauritius; Nigeria; Rodrigues; Rwanda; Seychelles; Sierra Leone; Sudan; Tanzania; Togo; Zambia and Zimbabwe.

Fissidens crispulus var. robinsonii (Broth.) B.C. Tan & Choy, J. Bryol. 24: 47. 2002

Plants yellowish green, curved when dry, 0.59 mm long, 2-3 mm wide, 5-8 pairs of leaves; leaves lanceolate in the upper part, margin smooth at tip, base of dorsal laminae rounded, costa prominent, excurrent, sheathing lamina open and unequal; cells of apical lamina and dorsal lamina rounded, quadrate to rounded- hexagonal, thick walled mamillose, cells of extreme base of sheathing lamina larger, limbidium absent**.** (Plate 4)

Habitat: On brown rock.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 14/09/2024, *Athira 2103*, 18/01/2025, *Athira 2132*, *Athira 2134.*

Distribution: India (Andaman & Nicobar Islands, Kerala, Tamil Nadu); Australia (Queensland) China, Malaysia, New Caledonia, Oceania, Philippines.

Fissidens hollianus Dozy & Molk.

Plants green to yellowish green, not much curled in herbarium, stem without central strand, mostly unbranched, yellowish green, 0.13-0.20 mm .8-18 pairs of leaves; rhizoids dark brown, smooth; axillary hyaline nodules absent. Lanceolate leaves with broad base, large vaginant laminae,reaching more than half or up to 2/3 of leaf length, closed or slightly open, 0.18- 0.20mm wide at base, unistratose; dorsal lamina wedge shaped towards base, narrow than vaginant laminae and apical lamina, dorsal lamina and apical lamina unistratose; costa excurrent in short apiculus, bryoides type; laminal cells irregularly polygonal, pluripapillose, limbidia that reach the apex of the vaginant lamina in well-developed plants, but are shorter in others, excurrent costa, distinct pluripapillae in laminal cells and papillose spores. (Plate 5).

Habitat - on bark of tree

Specimen examined - Iringole kavu, Perumbavoor, Ernakulam (64.17m), 20/07/2024, *Athira 2070*, and 18/01/2025, *Athira 2118.*

Distribution - India (Karnataka, Kerala, Andaman Islands, Tamil Nadu) Borneo, Celebes, China, Indonesia, Japan, Java, Laos, Malaysia, Myanmar, New Guinea, Philippines, Sumatra, Taiwan, Thailand, Vietnam

Fissidens pellucidus Hornsch., Linnaea 15: 146. 1841

Plants small, growing in loose tufts, stem simple, leaves curls in herbarium; yellowish orange stem, central strand weakly differentiated, 10-16 pairs of leaves; rhizoids reddish, smooth, axillary nodules absent; leaves small, lanceolate with acute to acuminate apex, margin serrate, leaves not overlapping, 5 times long as wide; limbidium absent, but few scanty elongated cells present in perichaetial leaves, vaginant laminae ± half open, small, reaching less than half the length of apical leaf, unistratose, basal vaginant cells near costa slightly elongated, dorsal lamina base round, reaching the insertion, not decurrent, dorsal and apical lamina unistratose; costa prominent, percurrent to slightly excurrent, bryoides type, rarely bifid at end; laminal cells often

guttulate, mid dorsal laminal cells irregularly rectangular, plane to slightly convex, mid vaginant laminal cells linearly oval to rectangular,, slightly convex; gemmae not found. (Plate 6).

Habitat: On land cutting and termite mount.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2054, Chandini 2054 and Athira 2058 a.*

Distribution: India (Kerala, Goa, Karnataka), Belize, Bolivia, Brazil, Caribbean, Chile, China, Philippines, Singapore, Sri Lanka etc.

Fissidens walkeri Broth., Rec. Bot. Surv. India 1(12): 315. 1899; Dixon, J. Indian Bot. 2: 177. 1921.

Plants not mat-forming but growing in groups; rhizoids smooth, dark brown; axillary hyaline nodule not present; small plants, 3-5.00 x 0.19-0.20 mm, pinnate, stem light green, central strand weakly differentiated or not differentiated; leaves dark green, curls in herbarium, alternate, 8-15 pairs of leaves, slightly overlapping; leaves lanceolate, apical and dorsal lamina and uniseriate; strong pale green costa with slight excurrentity or coming to a termination at the top. Normally bearing lanceolate leaf with acute apex, deeply serrate margin, narrowly open limbidium, and a series of solitary conical mammillose laminal cells. (Plate 7).

Habitat: On brown rock and on bark of tree.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 27/07/2024, *Athira 2082,* 18/ 01/2025, *Athira 2135.*

Distribution: Endemic to South India (Tamil Nadu, Karnataka, Goa, Maharashtra and Kerala).

Fissidens Sp. 1

Plant dark green in colour growing as mat, ranging from 2 - 3 mm long, and 2 - 3 mm wide including leaves, older parts yellowish, leaves not overlapping, rhizoides smooth, brownish; stem black in colour , 4 - 5 pairs of leaves, central strand differentiated; leaves oblong lingulate, margin undulating smooth. The leaf measured 1.16 mm in length, with apex width 0.13 mm, middle lamina width 0.26 mm, upper base width 0.22 mm, base width 0.19 mm, sheathing lamina width 0.09 mm, and sheathing lamina length 0.47 mm. apex apiculate or mucronate, leaf symmetric at apex; limbidium not seen ,vaginant laminae shorter than 1/2 of apical lamina, closed or slightly open,dorsal lamina narrowing towards base.laminal cells irregularly hexagonal.

This species is characterised by oblong lingulate leaves, undulating smooth margin, limbidium absent.

This species shows characters that are different from other species recorded further studies are needed to reveal its identity. (Plate 8).

Habitat : On concrete wall

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 14/09/2024, *Athira 2109.*

Fissidens sp. 2

Plant is green in colour, ranging from 3 - 5 mm long, and 3 - 4 mm wide including leaves, older parts yellowish, leaves not overlapping, rhizoides smooth, brownish; stem green same colour as leaves , slightly brown towards base, 13-14 pairs of leaves, central strand differentiated; leaves oblong lingulate, margin crenate, 3.26 - 3.30 x 0.09 -0.10 mm, apex apiculate or mucronate, leaf slightly asymmetric at apex; limbidium restricted to vaginant laminae, one or two rows at vaginant laminae base, uniseriate; vaginant laminae reaching more than 1/2 of apical lamina, closed or slightly open, dorsal lamina narrowing towards base, round. laminal cells irregularly pentagonal or hexagonal. Gemmae not found.

This species is characterized by oblong lingulate leaves, serrate margin, limbidium on vaginant laminae. Since this species shows characters that are different from other sp. Recorded further studies are needed to reveal its identity. (Plate 9).

Habitat - Epiphytic

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 18/01/2025, *Athira 2122.*

Family - LEUCOBRYACEAE

Large, hyaline (transparent) cells that aid in water storage give these family of mosses their characteristic thick, whitish-green leaves. Typically lance-shaped, the leaves have a strong midrib (costa) that extends past the leaf apex and ends in a hair-like tip. Usually covered in dense, overlapping leaves, the stems give the plants a tufted or cushion-like look. Sporophytes have ovoid or cylindrical capsules with a fully formed peristome.

Genus- *Leucophanes*

They are small-sized, cushion- or mat-forming mosses and possess lanceolate to ovate leaves with hyaline (clear) margins and papillose upper surfaces that assist with water retention. Leaf margins are frequently strongly revolute (rolled), and stems are short with rhizoids that assist in attachment. The sporophyte has a cylindrical or ovoid capsule, occasionally with a heavily developed peristome, and a conical or beaked operculum. Leucophanes species are high-humidity plants and have the characteristic leaf morphology and epiphytic and lithophytic habit adaptation.

Leucophanes octoblepharioides Brid., Bryol. Univ. 1: 763. 1827.

Whitish green, tropical epiphytes with crowded spreading leaves. Stem without central strand. Leaf with a prominent 'midrib' because of the presence of a median stereide band. Costa shows one layer of 4-angled chlorocysts between 2 layers of leucocysts (there may be more layers of leucocysts near base). Leaf bordered through- out by 2 or 3 rows of very narrow, greatly elongated cells. Lamina wings of hyaline cells confined to the leaf base only. Fruiting condition rare. Seta slender, terminal, soon becoming lateral; capsule erect, cylindrical; peristome teeth 16, not cleft or striped, papillose; operculum conic-rostrate; calyptra cucullate with entire base, mostly companulate; branch leaves ovate or ovate lanceolate, lateral rows often slightely assymmetrical, usualy contracted at top; leaf cells linear, usually seriate-papillate, rarely smooth, alar usually differentiated; seta long, mostly smooth, capsule horizontal, globose, ovate, annulus persistent, operculum conical, short. (Plate 10).

Habitat: On bark of tree

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2057*, 20/07/2024, *Athira 2076*, *Athira 2080*.

Distribution: India (Assam, East Bengal,Tamil Nadu, Kerala), Africa, China,

Family: CALYMPERACEAE Kindb.

Plants small to fairly robust, mostly epiphytic, rarely growing on rocks. and on soil; stem erect, leaves linear-lanceolate to lingulate from a semi- sheathing broader base, sometimes with hyaline or thickened border, leaves mostly of two types; gemmiferous and non-gemmiferous; cells at upper half small, often papillose, basal hyaline, bordered by green, isodiametric cells; costa

strong, often rough papillose; capsule erect, peristome absent or with 16 deeply inserted teeth, operculum conic-rostrate.

Key to the genera

1a. Plants whitish green, vegetative leaves not differentiated……*Octoblepharum*

1b. Plants yellowish-green, vegetative leaves differentiated into gemmiferous and non-gemmiferous……..……..2

2a. Leaves without hyaline border……..3

2b. Leaves with hyaline border……*Thyridium*

3a. Costa ending below apex to excurrent, cells at upper half chlorophyllose, small, mostly isodiametric……..…….…… *Calymperes*

3b.Costa percurent, chlorophyllose lamina usually involute, at apex forming a lax funnel-shaped collar above the tip of the costa……...……. *Chameleion*

GENUS: ***Calymperes*** Sw., F. Weber, Tab, Exhib. Calyptr. Operc. Musc. Frond. Gen. 2. 1813. 1814.

Plants small, yellowish-green, erect; stem simple or branched, leaves often dimorphic, gemmiferous and non-gemmiferous, narrow, broadly lingulate, lanceolate or linear with a hyaline, semi sheathing base, apex narrow, sometimes abrupt; costa conspicuous, ending below apex to excurrent; cells at upper half chlorophyllose, small, mostly isodiametric, in some protrusions arise from the vental surface, protrusions sometimes papillose, bearing dorsally 1 to 2 papillae., cells at base hyaline, large, empty, gemmae produced in radial masses, often from the modified apices of specialized leaves, fusiform to clavate, sometimes filamentous and branched, multicellular, smooth, seta normally exerted.

Calymperes erosum C. Muell., Linnaea 21: 182. 1848.

Plants highly curved and clustered in herbarium, pale yellow in colour when moistened it become light green in colour, bushy in appearance. 3-6 mm long, 1.5-3 mm wide including leaves; stem reduced and brown in colours, leaves 0.5 to 3.5 mm long, lingulate to lanceolate, distal lamina sometimes involute, leaf apex acute, costa ending in apex to excurrent above hyaline base rough with small acute projections; cells isodiametric, hyaline cells overlap with the laminal cells, just

above it the marginal cells of hyaline region consisting of 3 rows of narrowly rectangular, thin walled cells, gemmiferous leaves with an excurrent costa. (Plate 11).

Habitat: On bark of tree.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 20/07/2024, *Athira 2081*, 27/07/2024, *Athira 2102*, 18/01/2025, *Athira 2125.*

Distribution: India; (Goa, Kerala, Tamil Nadu), Sri Lanka, Myanmar, China, Africa and America.

GENUS: ***Octoblepharum*** Hedw., Sp. Musc. 50. 1801.

Plants tufted, glossy, whitish-green, tinged with brown colour; leaves crowded, rigid, often fragile, lingulate, form an oblong or narrowly obovate, concave base, limb of leaves flat or plano-convex at upper half; costa broad and thick, occupying half of the leaf base and filling the upper part; central and basal laminal cells irregularly rectangular; seta erect, less than 1 cm long; capsule erect,ovoid, symmetrical, peristome 8 teethed, undivided, broadly lanceolate, perforated or teeth 16 in 8 pairs; calyptra cucullate.

Octoblepharum albidum Hedw., Sp. Musc. 50. 1801.

Plant whitish green, upto 3-5 mm, leaves crowded on stem without central strand, leaves lingulate, base concave, sheathing base broad, apiculate at tip, tip minutely serrated; leaf base with 5-6 layers of hyaline linear cells; costa absent; capsule erect, peristome 8 teethed, seta upto 3-7mm long. (Plate 12).

Habitat: On tree bark and on logs.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2051*, *Athira 2058 b*, 27/07/2024, *Athira 2091*.

Distribution: Widely distributed species. India (Kerala, Karnataka, Tamil Nadu) North-east India (Kumaon, Sikkim); Bolivia, China, Indomalayan region, Madagascar, Nepal, Peru, Philippines and Sri Lanka.

Chameleion peguensis **(Besch.) L.T. Ellis & A. Eddy**

Plant densely matted with rhizoids below, forming mats or tufts. With a plant size of 1.44 mm long and 3.11 mm broad. 2.07 mm long and 0.68 mm broad leaf .Leaves strongly dimorphic with nongemmiferous leaves erect to patent narrowly to broadly lingulate, distal lamina often

incurved; apex broadly obtuse to rounded or rounded-truncate, entire. Costa ending just below apex; on the ventral surface near costal apex sometimes with one or two low lamellae Gemmiferous leaves are funnel shaped and projected above non-gemmiferous leaves. Costa strong ending below apex, distally rough with many superficial cells drawn out as acute projections. Chlorophyllose lamina usually involute, at apex forming a lax funnel-shaped collar above the tip of the costa; cells subquadrate to long subrectangular, dorsally and ventrally convex or drawn out as acute projections. Hyaline lamina narrow with cells similar to those in nongemmiferous leaves. Leaf margins above hyaline base similar to those in nongemmiferous leaves but lacking lamellae. The cross section of leaf shows the midrib with two centrally positioned large cells, encircled on one side by six large cells arranged in an arc-like formation, and externally bordered by a peripheral layer of five smaller cells. Lamina has uniseriate cells. A single mature gemmae is about 0.23 mm long and 0.04 mm wide. (Plate 13).

Habitat: Epiphytic.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2056, Athira 2066,* 27/07/2024*, Athira 2089,* 18/01/2025*, Athira 2124.*

Distribution: Very rare species in Kerala. Reported Western Himalayas only.

GENUS **: Thyridium** Mitt. in J. Linn. Soc . Bot., 10 : 188 (1868)

Main stem creeping with erect shoots. Leaves oblong or lingulate from a broad, erect, sheathing, hyaline base. Hyaline border of elongated cells broad and extending above middle of leaf. Upper lamina cells small, incrassate, papillose, distinct from hyaline cancellinae at leaf base. Seta terminal on lateral branches. Peristome teeth papillose. Calyptra cucullate.

***Thyridium cardotii* Fleisch. in Musci FI. Buitenz**

Horizontal stem growing on bark usually ranging from 0.8 - 1.5 cm or more long with vertical shoots upto 2 - 3 mm. Shoot green to yellow green , thickly covered by erectopatent , somewhat undulating leaves on the upper half of mature shoots and the whole stem of younger shoots .Leaves folded and moderately curled when dry; a single leaf is 0.30mm. long including the base which is +-0.5mm. wide at middle lamina and 0.49- 0.53 mm. wide at upper base; tip broadly pointed; margin serrate denticulate from top of base to a little behind tip. A wide border of long, narrow, cartilaginous cells is about 8 to 10 rows wide at top of base, narrowing down at extreme base and

to 1 row in the top lamina, finally borders extreme tip. Cancellinae triangular with the top straight but slanting down on both sides near margin. ¼ area of leaf (base) consists of hyaline cells up to 15 rows of hyaline, rectangular, large cells. Leaves ending in a bunch of club-shaped gemmae mixed with some rhizoids in the upper leaves. Sporophyte not seen.

In cross section, the midrib exhibits two prominently large, centrally positioned cells. The lamina consists of a uniseriate cells with serrated margin. (Plate 14).

Habitat: On bark of tree

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 27/07/2024, *Athira 2097,* 18/01/2025, *Athira 2126.*

Distribution: Upper Assam, Burma, Cambodia, Vietnam, Java. (Gangulee 1969, Dandotiya *et. al.*, 2011).

Note: This species has been recorded earlier from North eastern region only. Hence the present collection is a new record to Peninsular India and the genus is a new record to Kerala.

Order: POTTIALES

Family: POTTIACEAE Schimp.

Plants yellowish-green, erect, usually small, ± 1-5mm, densely tufted; leaves linear-lanceolate to spathulate, crowded, mostly crispate when dry; costa single, strong, percurrent; cells usually thin walled, rectangular, hyaline at base, small, papillose, often obscure above, alar cells absent; seta usually long, erect; capsule erect, cylindrical to ovate-cylindrical, calyptra narrow, cucullate, peristome usually absent.

GENUS: *Hyophila* Brid., Bryol. Univ. 1: 760. 1827.

Plants small to medium sized, forming mats; leaves oblong-lingulate, broad, apiculate, margin flat when moist, inrolled when dry, apex obtuse, often toothed at apex; cells at basal part rectangular, hyaline, upper cells small, rounded chlorophyllose, papillose; costa excurrent, seta apical, erect, capsule erect.

Hyophila involuta (Hook) A. Jaeger, Ber. Senckenberg Naturf. Ges. 1871. 72: 356. 1873

Plants greenish, 0.4-7.5 mm long, leaves appressed when dry, leaves oblong to lingulate, leaves inrolled when dry, apex obtuse, toothed at apex, basal hyaline cells, rectangular in shape,

47.15 x 18.86 - 50.88 x 47.15 um, upper cells rounded, 18.86 x 9.43 - 37.72 x 18.86 um, papillose, chlorophyllose, leaf tip acuminate with 37.72 x 18.86 µm; costa strong percurrent; capsule erect, reddish brown in colour, seta elongate, up to 0.8-1.5mm. (Plate 15).

Habitat: On land cuttings, on bark of tree, friable rocks and on small brown rocks.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 20/07/2024, *Athira 2069*, 27/07/2024, *Athira 2089, Athira 2090, Athira 96, Athira 2106.*

Distribution: A widely distributed species. India (Kerala, Karnataka, Mysore, Tamil Nadu, Palni hills, Nilgiri hills, Gujarat, Madhya Pradesh, Orissa), North east India (Assam, Arunachal Pradesh, Bengal, Bihar, Darjeeling, Western Himalayas); China, Japan, Java, Korea, Myanmar New Guinea, Nepal, Philippines, Sumatra Taiwan, Sri Lanka .

Order: BARTRAMIALES

Family: BARTRAMIACEAE Schwaegr.

Plants densely tufted, usually robust; leaves lanceolate, acuminate, dentate or serrate; costa percurrent or excurrent, often toothed on back; cells narrow, rectangular, usually mamillose or papillose; seta lateral or terminal; capsule subglobose, mostly furrowed.

GENUS: ***Philonotis*** Brid., Bryol. Univ. 2: 15. 1827.

Plants light yellowish to greenish, very slender in dense tufts, interwoven with sooth or faintly papillose rhizoids, dichotomously branched, with whorled subfloral innovations, leaves elongate-linear, acuminate, serrate or denticulate often by means of paired papillae; costa percurrent to excurrent; cells near the apex elongate to shortly rectangular, 5-6 sided, basal cells large, thin walled, mamillose on the upper or on both ends; seta elongate, erect, capsule inclined to horizontal, nearly globose, striate, mostly compressed in the middle.

Philonotis hastata (Duby) Wijk & Marg., Taxon 8:74. 1959

Plants pale greenish, leaves curled and appressed to stem when dry, plant 1-1.2 mm long, 5-8 mm wide with leaves, yellowish brown in colour, leaves linear lanceolate-lingualte, shortly acuminate, narrow, small, marginal cells serrated and projecting out, cells hexagonal-rhomboidal, costa prominent and vanishes much below the tip, leaf tip rounded, costa having 2 rows of cells, cells contains chloroplast, cells thin walled, apical cells hexagonal in nature, cells adjacent to the

costa are elongated than marginal cells, leaf marginal serration not prominent in the base of the cells. (Plate 16).

Habitat: On land cuttings, on concrete wall and on logs.

Specimens examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2055 b*, 20/07/2024, *Athira 2075*, 27/07/2024, *Athira 2086.*

Distribution: India, (Kerala, Tamil Nadu, Andra Pradesh, West Bengal, Assam, Sikkim), Sri Lanka, Borneo, Bolivia, Java, Thailand, Celebes, Philippines, Japan, Taiwan, Chile, Oceanic Island, Peru, Venezuela, Africa, South America and Australia.

Order: HYPNALES

Family: SEMATOPHYLLACEAE Broth.

Plants slender to robust, glossy, stem prostrate or erect, irregularly or pinnately branched; leaves ovate, acuminate; costa short, double or absent, cells linear, smooth or papillose, alar cells few, large vesicular and differentiated, mostly coloured; seta long, smooth or papillose, capsule small, horizontal to inclined, operculum rostrate, calyptra cucullate, smooth.

Key to the genera

1a. Plants yellowish, axillary branch up to 6 mm and more in length, middle cells of the leaf larger than basal cells…….…….*Sematophyllum*

1b. Plants greenish, axillary branch up to 5 mm and smaller, middle cells smaller than basal cells..... *Taxithelium*

GENUS: ***Sematophyllum*** Mitt., J. Linn. Soc. Bot. 8: 5. 1864.

Plants small to robust, glossy in dense mats, stem creeping, branches crowded, densely foliate; leaves erect to spreading, ovate to oblong-elliptic, obtuse, apiculate gradually or abruptly long accuminate, sometimes hair pointed, weakly toothed above; costa absent; cells rhombic, alar cells large, oblong inflated, coloured; seta usually elongated reddish; capsule erect to horizontal, ovoid to oblong.

Key to species

Alar differentiated at base at an angle by a row of about 4 tinted, inflated oblong cells at base ……..…..……*Sematophyllum caespitosum*

Alar differentiated, hyaline, broadly elliptical to oblong,……..…….*S. subhumile*

Sematophyllum caespitosum (Hedw) Mitt., J. Linn. Soc. Bot, 12: 479. 1869.

Plants light greenish, tufted, main stem creeping, 0.5-25 mm long, branching irregularly, leaves appressed on stem when dry, spirally arranged on stem, axillary branches short, leaves 0.2-0.6 mm long, broadly ovate-lanceolate, apex usually narrow, leaf tip narrow, acute, base broad, middle bulged, margin serrated, leaf cells narrow rhomboid at apex, 15 x 7.5 - 20 x 10 μm, middle cells larger, 50 x 2.5 - 70 x 7.5 μm, basal cells 20 x 12.5 μm, marginal cells 30 x 7.5 μm, cells show papillose development on tips; alar differentiated at base at an angle by a row of about 4 tinted, inflated oblong cells at base, another row of shorter cells on on top of them. (Plate 17).

Habitat: On bark of tree.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 29/06/2024, *Athira 2062*, 14/07/2024, *Athira 2104*, 18/01/2025, *Athira 2114.*

Distribution: In India (Western Himalayas, Eastern Himalayas) South India (Kerala, Karnataka, Tamil Nadu); Europe, Japan, Korea, Malaysia, Sri Lanka and United states of America.

Sematophyllum subhumile (Müll. Hal.) M. Fleisch., Musci Buitenzorg 4: 1264. 1923

Monoicous. Yellow- to brownish green, glossy, medium-sized plants often forming tufts on tree base. Main stem creeping several centimetres, branching irregularly. Secondary branches pinnate, suberect. Leaves not dense, erectopatent, concave, ovate- lanceolate from ovate base, 1.3x0.4 mm. (stem leaves larger), margin crenulate at tip, often revolute on both sides at middle of leaf. Ecostate. Leaf cells narrow elongate. Alar differentiated, hyaline, broadly elliptical to oblong, Sporophytes on main stem or principal branches. Seta erect flexuose, slender, Capsule nodding horizontal, oval, showing apophysis when dry. Operculum long rostrate. Exothecial cells collenchymatous. Calyptra cucullate. Annulus not developed. Peristome normal. (Plate 18).

Habitat: On bark of tree and rock wall.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam 29/06/2024, *Athira,2052*, 27/07/2024, *Athira, 2088*, 14/09/2024, *Athira ,2101*, 18/01/2025, *Athira 2133.*

Distribution: East Nepal-Tokyo Univ. Expdn. (1300 m.) , Upper Assam-Cole 8 (Jorhat)

GENUS: ***Taxithelium*** Spruc. ex Mitt., Linn. Soc. Bot. 12: 496. 1869.

Plant yellowish-green, corticolous, non-glossy plants in dense flat mats, main stem creeping, usually regularly pinnate branched, ultimate branches small.

Key to species

Leaf margin in rolled at one side alar cells smooth….. ……*Taxithelium nepalense.*

Leaf margin unrolled; alar cells papillose……..…… *Taxithelium sp.*

Taxithelium nepalense (Schwagr.) Broth., Monsunia 1: 51. 1899.

Plants Robust green in colour, 5-20 mm long, leaves appressed on stem when dry, irregularly branched, main stem creeping, branch length up to 2-5 mm, leaf margin denticulate at tip; costa absent, leaf cells spindle shaped with one row of papillae, alar cells smooth, cells large somewhat rectangular in shape; sporophyte present on main stem, capsule 0.5-0.9mm long, with long seta, 10- 15mm, peristome double layered. (Plate 19).

Habitat: On roots of palm tree and bark of tree.

Specimen examined: Iringole kavu, Perumbavoor, Ernakulam (64.17m), 27/07/2024, *Athira 2098,* 14/09/2024, *Athira 2099.*

Distribution: India (Eastern Himalaya, North-East India: E. Ghats (Orissa) and W. Ghats of Kerala, Tamil Nadu (Kanyakumari & Madurai), Bangladesh and Nepal.

Taxithelium sps.

Plant green in colour, ranging from 2- 4mm in length and 1 – 1.5 mm in width including leaves, they are found creeping to ascending growth habit, with irregularly branched stems that bear small, overlapping leaves. Leaves are ovate-lanceolate to linear. Leaf measured 0.7 – 0.9mm in length, with apex width 0.05mm, middle lamina width 0.24 mm, upper base 0.21 – 0. 30mm. Leaf margin unrolled; alar cells papillose and leaf cells are elongated with a papillose or smooth surface.

This species shows characters that are different from other species recorded further studies are needed to reveal its identity. (Plate 20).

Habitat - rock

Specimen examined - Iringole kavu, Perumbavoor, Ernakulam, 29/06/2024, *Athira 2059*, 27/07/2024, *Athira 2088*, 18/01/2025, *Athira 2118.*

	Class	Order	Family	Genus	Species
1	Bryopsida	Dicranales	Fissidentaceae	*Fissidens*	*crispulus* var *crispulus*
2		Dicranales	Fissidentaceae	*Fissidens*	*crispulus* var *robinsonii*
3		Dicranales	Fissidentaceae	*Fissidens*	*hollianus*
4		Dicranales	Fissidentaceae	*Fissidens*	*pellucidus*
5		Dicranales	Fissidentaceae	*Fissidens*	*walkeri*
6		Dicranales	Fissidentaceae	*Fissidens*	*Sp.*1
7		Dicranales	Fissidentaceae	*Fissidens*	*Sp.*2
8		Dicranales	Leucobryaceae	*Leucophanes*	*octoblepharioides*
9		Dicranales	Calymperaceae	*Calymperes*	*erosum*
10		Dicranales	Calymperaceae	*Octoblepharum*	*albidum*
11		Dicranales	Calymperaceae	*Chameleion*	*peguensis*
12		Dicranales	Calymperaceae	*Thyridium*	*cardotii*
13		Pottiales	Pottiaceae	*Hyophila*	*involuta*
14		Bartramiales	Bartramiaceae	*Philonotis*	*hastata*
15		Hypnales	Sematophyllaceae	*Sematophyllum*	*caespitosum*

16		Hypnales	Sematophyllaceae	*Sematophyllum*	*subhumile*
17		Hypnales	Sematophyllaceae	*Taxithelium*	*nepalense*
18		Hypnales	Sematophyllaceae	*Taxithelium*	*Sp.*

Table 1 : As per the classification of Goffinet *et. al.* (2008)

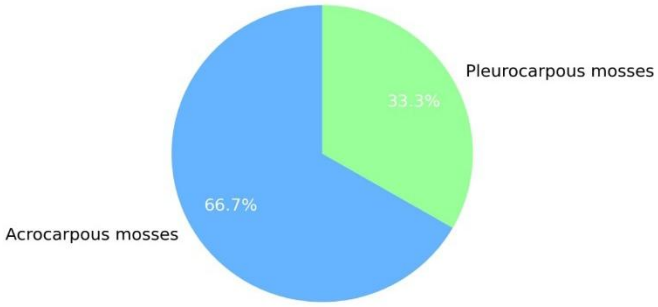
DISCUSSION

The present collection of 18 taxa belongs to 10 genera and 6 families. The family Fissidentatceae are the monotypic with single genus viz., *Fissidens* represented by six species in the Iringole Kavu, of Ernakulam district. The five species identified are *F. crispulus* var *crispulus*, *F. crispulus* var *robinsonii*, *F. pellucidus*, *F. walkeri*, *F. hollianus*. Two plants are identified as Fissidens but further investigation is required to identify upto species. Among these the frequency of occurrence of *Fissidens crispulus* is very high. Fissidens walkeri, a distinctive moss species endemic to the western ghats is also obtained from the present study area. The dominance of the genus *Fissidens* (represented by five identified varieties/species and two unidentified) aligns with observations from other bryophyte surveys in tropical regions, where this genus is often well-represented due to its adaptability to various microhabitats, including shaded and moist conditions prevalent in such environments (Gradstein *et. al.*, 2001).

The distribution of the family Fissidentaceae followed by Calymperaceae, Bartramiaceae and Pottiaceae respectively. These families are known to be significant components of tropical and subtropical bryophyte communities, often found on various substrates like tree bark, decaying wood, and soil (Churchill & Linares, 1995).

Calymperes erosum, *Chameleion peguense*, *Philonotis hastata* and *Hyophila involuta*, are the widely distributed species. *Chameleion peguense* of the family Calymperaceae is a rare species. *Thyridium cardotii* reported as a new distributional record to Peninsular India and the genus is a new record to Kerala. Then family Sematophyllaceae with two genera Sematophyllum and *Taxithelium* each with two species, *Sematophyllum subhumile, S. caespitosum, Taxithelium nepalense* and *Taxithelium sps*. respectively. The family Leucobryaceae consists of one species, *Leucophanes octoblepharoides.*

Among the 18 mosses, 6 species are Pleurocarpic and 12 species are Acrocarpic. The Pleurocarpic mosses prefer to grow on bark and rock, which are mostly appressed to substratum. The Acrocarpic mosses are distributed in different microhabitats. (Graph 1).



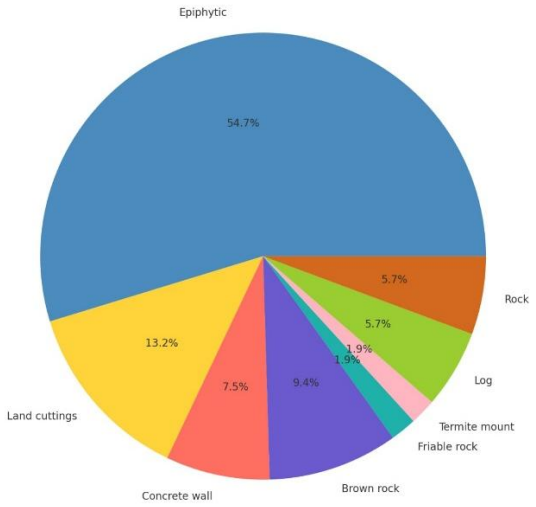
Graph 1: Distribution of Acrocarpic & Pleurocarpic Mosses.

The emphasis on morphological and anatomical features in this study is particularly relevant for bryophyte classification. Identification of mosses is basically based on gametophytic features. The emphasis in the study on attributes like habit of growth (acrocarpous or pleurocarpous), stem features, leaf form, size, and disposition goes straight to the most important morphological features used to distinguish among moss species. These are observations that serve as a basis for comparing the Iringole Kavu moss flora with other areas and for interpreting more general patterns of moss distribution.

Furthermore, the study delves into the anatomical details of the moss species. Examining cellular features within leaf sections, including cell shape, wall thickness, and specialized cell types like stereids or guide cells, offers a deeper understanding of the structural adaptations of these mosses. These anatomical characteristics can be crucial for distinguishing between closely related species and for inferring ecological adaptations. The use of precise terminology, including terms such as hyaline cells, lamellae, alar cells, and specific descriptors of costa structure (e.g., excurrent, percurrent, subpercurrent), showcases a rigorous scientific approach. This standardized terminology ensures accurate communication of the findings and contributes to the broader field of bryology.

The Micro and Macrohabitat of all the species varies. Terrestrial species are most common in the study area. Among the terrestrial habitat soil harbours most number of species followed by land cuttings. *Fissidens* and *Hyophila involuta* are the widely distributed species and prefers to grow in a wide range of habitats. *F. crispulus* var *crispulus* on land cuttings, *F. crispulus* var *robinsonii* on concrete wall, *F. pellucidus* on land cutting and termite mount, *F. walkeri* on tree trunk , *F. hollianus*. *Octoblepharum albidum* prefers to grow on tree trunk and on logs. *Chameleion peguense* found epiphytic on tree. *Philonotis hastata* on land cuttings, on concrete wall and on

logs. *Sematophyllum caespitosum* are found on bark of trees. While *Sematophyllum subhumile* and *Taxithelium* sps. on bark of tree. *Taxithelium nepalense* are found on roots of palm tree. (Graph 2)



Graph 2 : Distribution of Mosses along Microhabit

This data provides a straightforward concept regarding the significant role played by habitat heterogeneity in establishing a broad variety of bryophyte populations, especially mosses. Other aspects of the environment such as water availability, amount of shade, and host substrate categories have considerable influence on the distribution as well as biodiversity of mosses. These results point to the intricate interaction between mosses and microhabitats, as mosses are extremely sensitive to microclimatic changes. Thus, the presence or absence of specific moss species can act as an important ecological indicator, reflecting overall environmental conditions and changes in the ecosystem. It is useful to recognize such dynamics in conservation and management of habitats, for they reflect the delicate balance supporting biodiversity within these unique communities.

The ecological survey carried out in Iringole Kavu provides useful information regarding the complex interplay between moss distribution and the particular microhabitat requirements found in this special environment. Observations show that the microclimate of the sacred grove is significantly different from that of the surrounding landscape, with observable differences in humidity, light levels, and possibly soil composition that become evident when closely examined. One of the most striking observations is the utter lack of some quite frequent moss species, specifically *Bryum*, that tend to flourish on a wide range of shaded environments. In almost every other shaded environment, *Bryum* will be found thriving. But throughout the course of this inquiry,

not a single *Bryum* specimen was found within the boundary of the sacred grove. This interesting absence suggests the presence of specialized ecological conditions that are not favorable to the survival or growth of this specific moss.

The unique microhabitat within the sacred grove may be determined by several factors, including varying humidity levels that may happen because of the dense canopy cover of the grove and the specific interaction between filtering light that passes through leaves. In addition, varying composition of the soil perhaps through deposition of organic matter and with the presence of other vegetation may also have a part to play in determining this unique ecological niche. Overall, these findings suggest that the Iringole Kavu sacred grove is a microhabitat which is notably distinct from the immediate environment, characterized by a distinct community of plants not usually found in less specialized environments.

The reported variety of moss species within Iringole Kavu accentuates the significant ecological function of sacred groves as havens for bryophyte communities. The research carefully documents the different morphological and anatomical characteristics of the observed mosses, which is an important reference point for subsequent scientific studies and conservation efforts. Such a complete documentation not only allows for comparisons with other geographic regions' moss communities but also the tracking of changes in ecology over time. In addition, it evaluates the extent to which different environmental conditions, including climate change and habitat modification, affect these sensitive moss communities.

Overall, the research stresses the need to study morphological and anatomical characteristics of mosses, finally presenting a comprehensive and scientifically sound report on bryophyte diversity in the Iringole Kavu ecosystem. The results enhance our understanding on taxonomic classifications and illuminate the intricate ecological processes behind these moss communities. Further, this book sets the solid foundation for future study and conservation aimed at safeguarding these valuable ecosystems. Further, more intensive exploration of the area may yet reveal even greater insight into the variety of bryophytes that it holds, with yet undiscovered new species and solidifying of conservation initiatives.

Joint Forest Management (JFM) program focused on promoting a greater involvement by local populations within the conservation as well as the management of the forests patches and sacred groves so as to establish the feeling of custodianship among citizens (Poffenberger & McGean 1996, Kolavalli 1997). In recent years, sacred groves have started to be identified as

World Heritage Sites, a status that not only recognizes their cultural and ecological significance but also gives them added layers of protection through international recognition and possible funding opportunities (Schaaf & Rossler 2010). Even after such efforts also integrity of sacred groves has come under significant threat due to a variety of factors, including waste disposal practices, deforestation, encroachment on natural habitats, trespassing, illegal collection and removal of small fallen timber, other forest products and other detrimental human activities. Iringole Kavu, a notable example of such a sacred grove, is grappling with these same issues. One of the most pressing concerns is the influx of plastic waste discarded by visitors, which not only tarnished the beauty of this sacred site but also possess serious environmental hazards. This careless disposal of plastics contributes to pollution, harms local wildlife, and disrupts the delicate ecosystem that thrive within these ancient groves, highlighting the urgent need for greater awareness and conservation efforts to protect these invaluable natural treasures.

Altogether 26 management strategies were recognized for the conservation and protection of these sacred groves. Even though the social barrier is more appropriate, a study revealed that in the present day socio-cultural context, physical barriers such as fencing and compound wall are needed to protect sacred groves till the attitude of stakeholders towards sacred groves becomes positive. They received greater research attention from anthropological as well as biological conservation points of view (Gadgil and Vartak, 1976; Tiwari *et. al.*, 1995; Malhotra *et. al.*, 2001). The social threats to sacred groves in Kerala that have been indicated in the literature include a variety of processes, including the transition from extended to nuclear family systems and subsequent changes in property ownership and house building (KSCSTE,2005).

CONCLUSION

The bryophyte studies on the Kerala state is very less compared to the diversity of the topography, vegetation, area and climate. The number of researchers and research centers working on this group is also meager. The regional approaches of studying the smaller areas with deeper intensity is probably the best method in developing a national database. The present work is significant in this aspect. The present study is aimed mainly to document the moss diversity of Iringole Kavu, a Sacred groove near Perumbavoor, Ernakulam district. The critical study of about 85 specimens of bryophytes collected from the Iringole Kavu, a Sacred groove during one rainy season yielded 54 mosses. Among these mosses 15 are identified up to species level and 3 upto generic level. One species of *Fissidens* shows all characters similar to *Fissidens walkeri* but needs further time to fix its identity. Total number of genus identified is 10.

This study provides a preliminary insight into the bryophyte diversity of the surveyed area, revealing a total of 16 identified moss species along with two unidentified *Fissidens* species.
The presence of species such as *Calymperes erosum*, *Octoblepharum albidum*, *Chameleion peguensis*, *Philonotis hastata*, and species within the Sematophyllaceae and Taxitheliaceae families (e.g., *Sematophyllum caespitosum*, *Sematophyllum subhumile*, *Taxithelium nepalense*, *Taxithelium sp.*) contributes to our understanding of the regional bryoflora.

Of particular interest is the record of *Thyridium cardotii*. The report mentions this as a new record to the Peninsular India and a new genus record to Kerala. This discovery highlights the potential for finding novel or previously unrecorded bryophyte taxa within the region, emphasizing the need for further, more comprehensive surveys. The presence of such a species suggests potential biogeographical links with the Andaman Islands and underscores the importance of these habitats as reservoirs of unique biodiversity.

The occurrence of *Hyophila involuta* and *Leucophanes octoblepharioides* adds to the diversity observed. *Hyophila involuta* is a cosmopolitan species often found in disturbed or calcareous habitats, while *Leucophanes octoblepharioides* is typically associated with humid, shaded environments. Their presence suggests a range of microhabitats are available within the study area.

The fact that two *Fissidens* species remain unidentified (*Fissidens sp1* and *Fissidens sp 2*) indicates the need for further taxonomic investigation, potentially involving detailed morphological examination and molecular analysis. The report specifically mentions *Fissidens sp*

2 as being reported from one sacred grove of Kerala, suggesting a potential ecological specificity or even a possibly undescribed species associated with these unique ecosystems.

The absence of a dedicated study on Bryophytes in previous floristic assessments of the Kavu, as highlighted in the introduction, makes this preliminary survey a crucial first step in documenting this important group of plants. Bryophytes play significant ecological roles in nutrient cycling, water retention, and as indicators of environmental health (Glime, 2007). Therefore, a more in-depth investigation into the bryophyte diversity, distribution, and ecological roles within the Kavu is warranted.

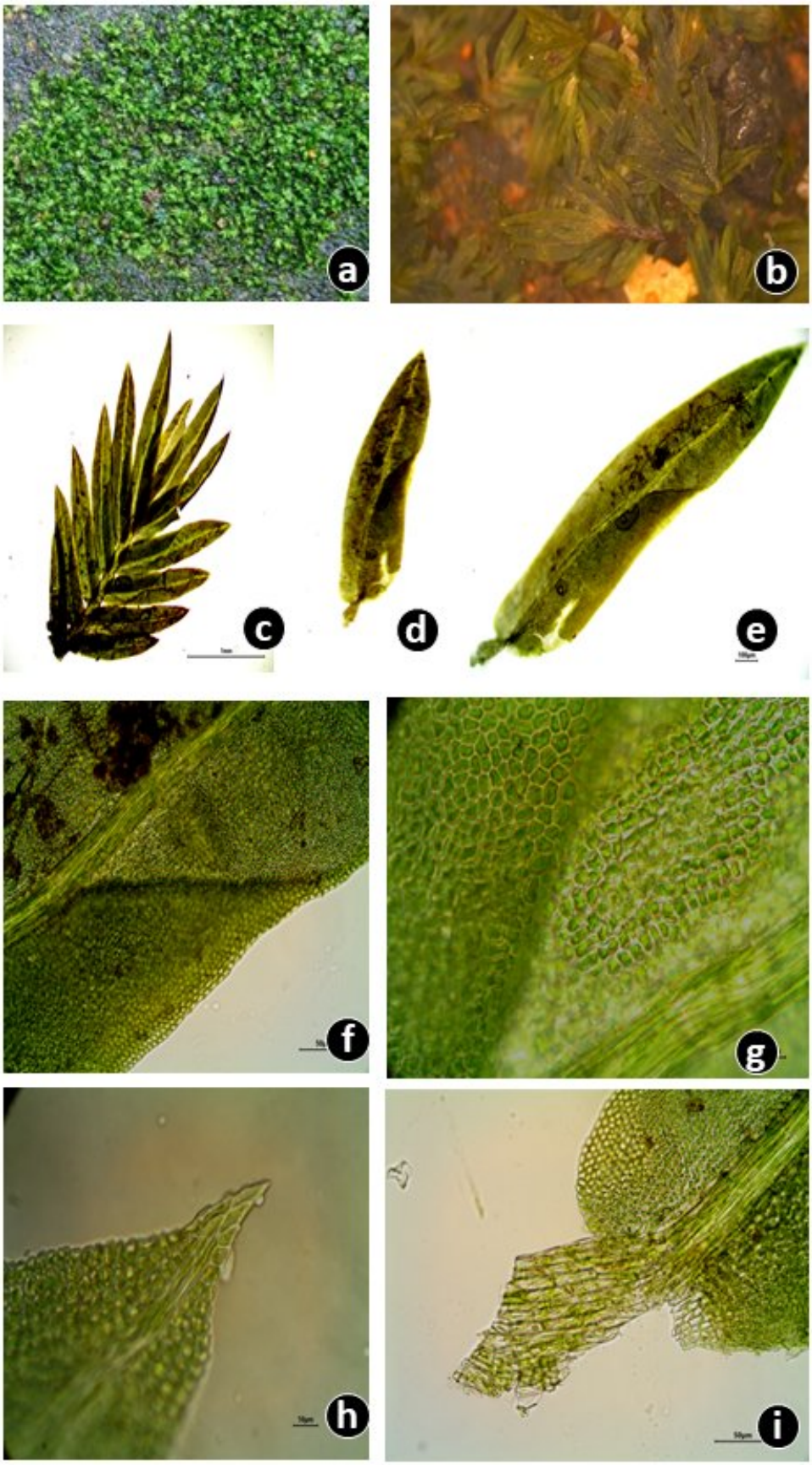


Plate 4. ***Fissidens crispulus* var *robinsonii* Broth.**, a&b. Habit, c. Single plant (4x), d. Single leaf (4x), e. Single leaf (10x), f. Sheathing lamina (40x), g. Sheathing and apical lamina (100x), h. Leaf apex (100x), i. Leaf base (40x).

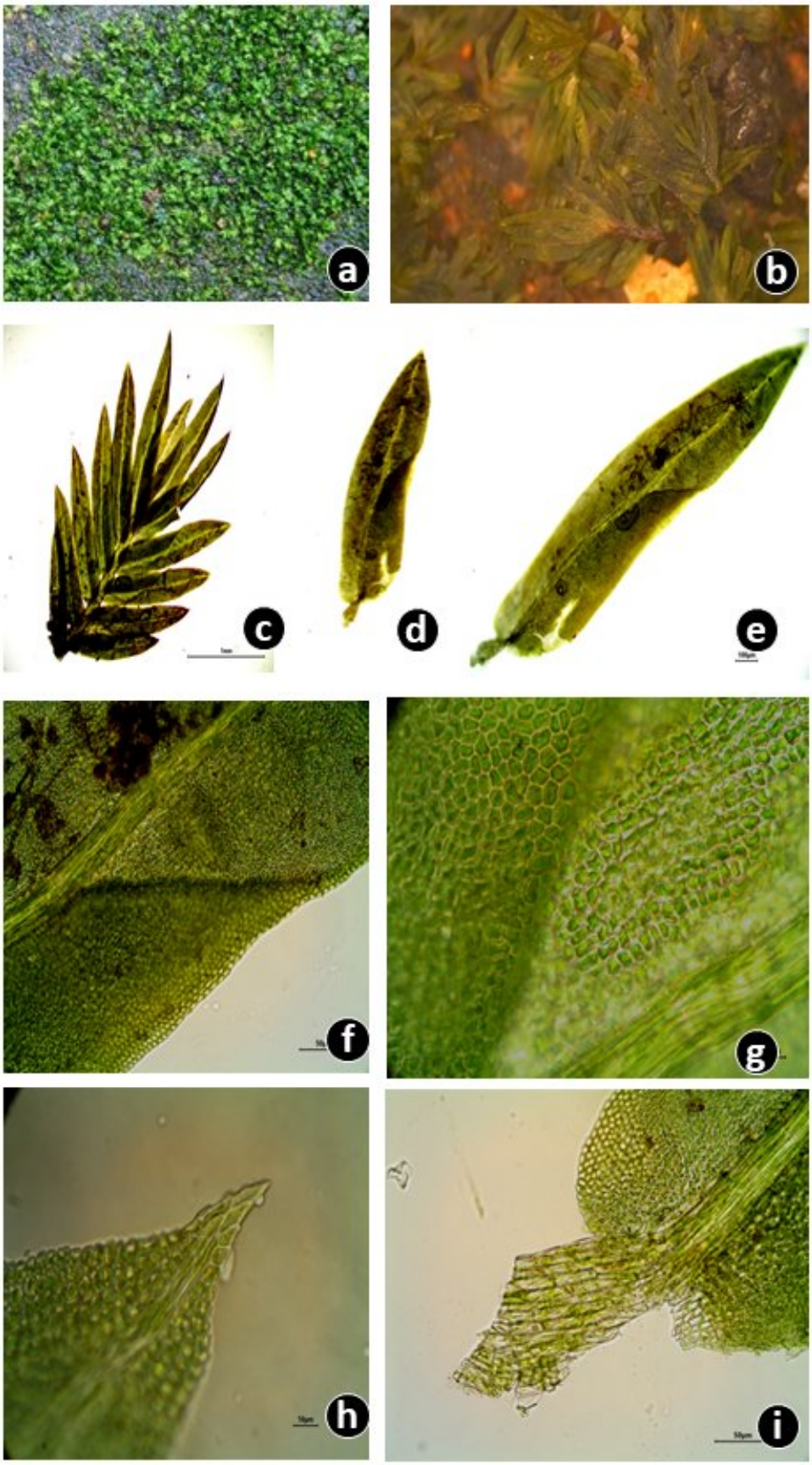


Plate 4. ***Fissidens crispulus* var *robinsonii* Broth.**, a&b. Habit, c. Single plant (4x), d. Single leaf (4x), e. Single leaf (10x), f. Sheathing lamina (40x), g. Sheathing and apical lamina (100x), h. Leaf apex (100x), i. Leaf base (40x).

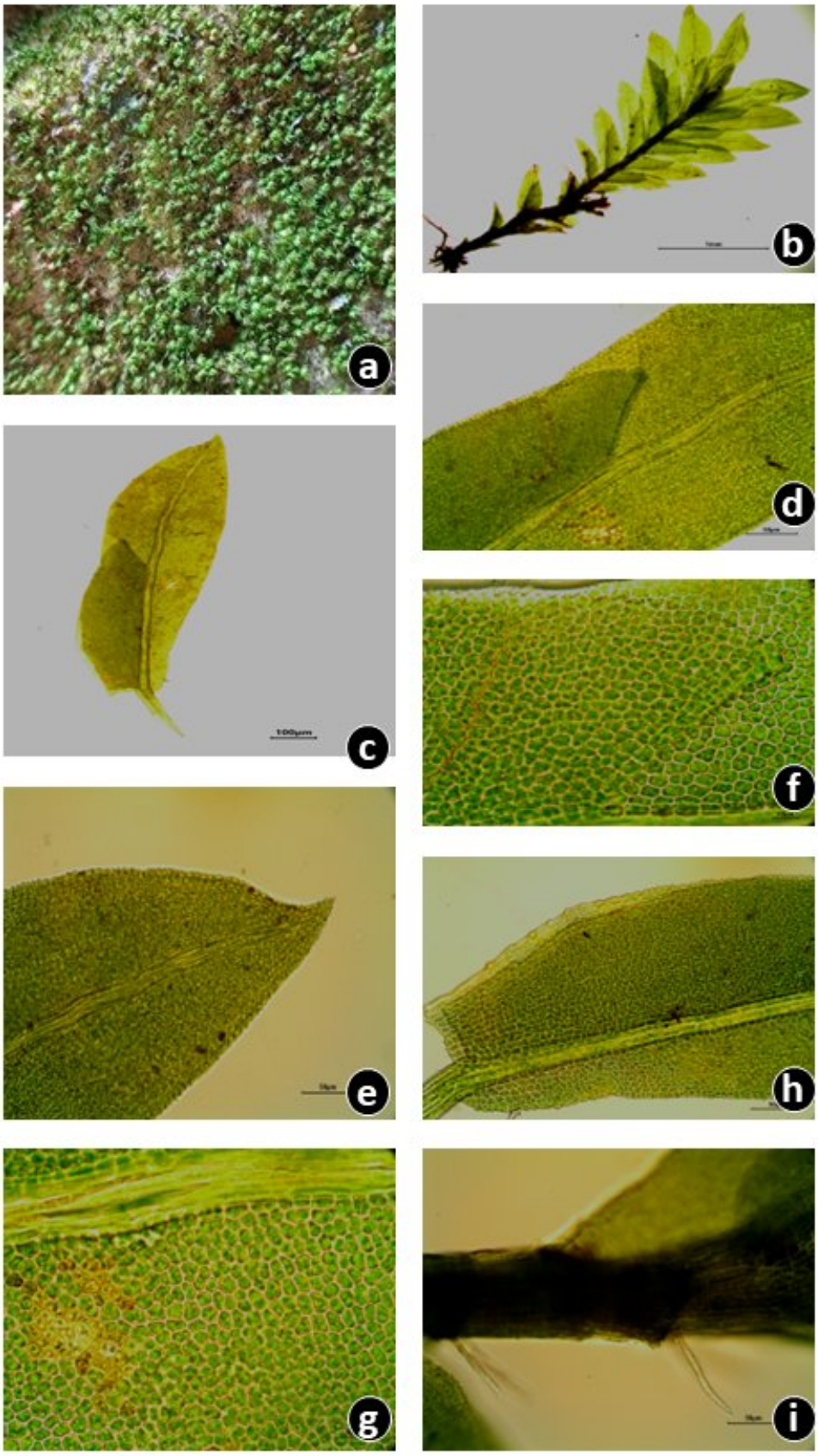


Plate 5. ***Fissidens hollianus*** **Dozy & Molk**. , a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Sheathing lamina (40x), e. Leaf apex (100x), f. Apex of sheathing lamina (100x), g. Cell(100x), h. Leaf base (40x), i. Stem glandular projection (40x).

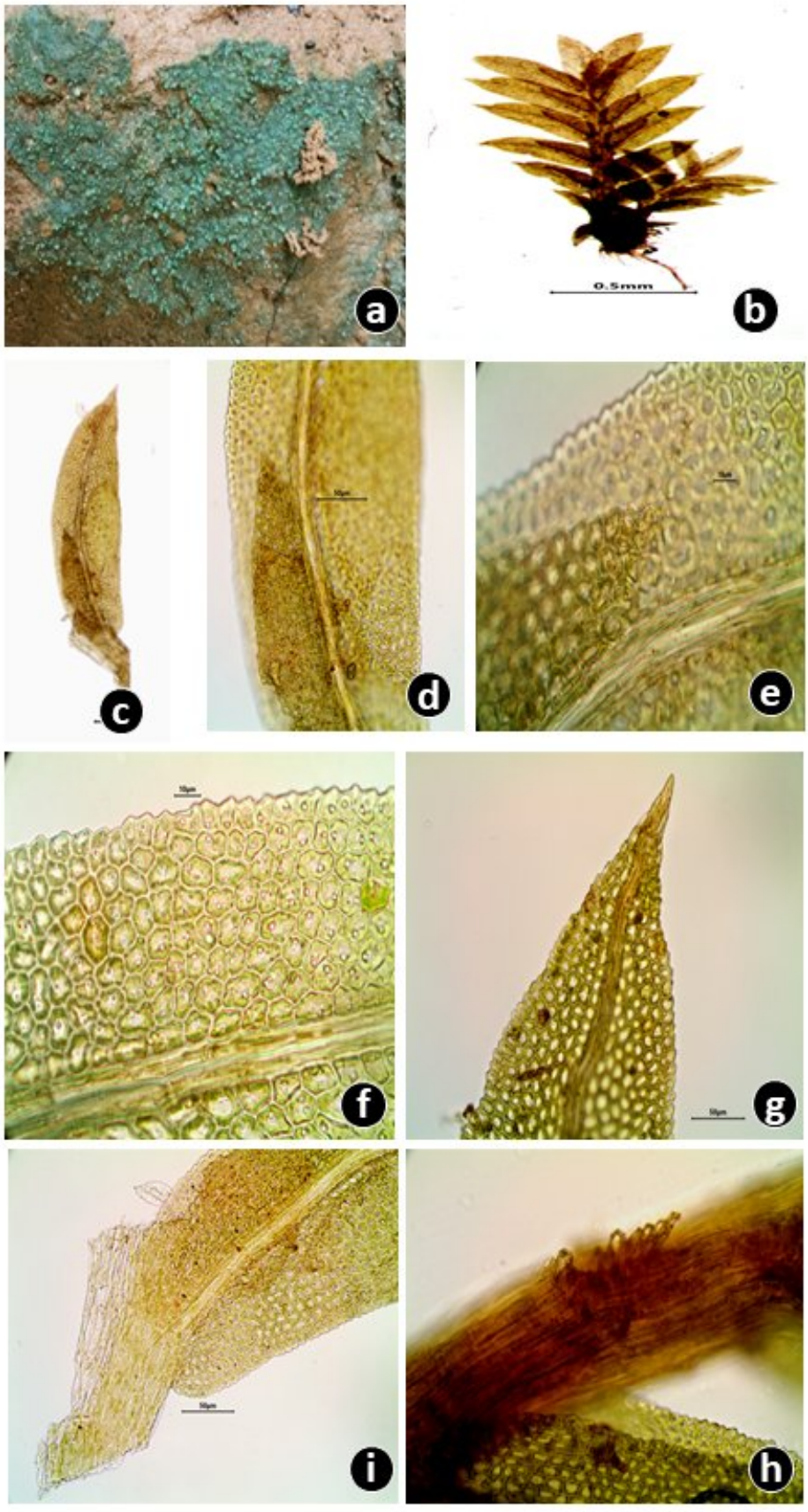


Plate 6. ***Fissidens pellucidus*** **Hornsch.**, a. Habit, b. Single plant, c. Single leaf (10x), d. Sheathing lamina (40x), e. Apex of sheathing lamina, f. Leaf margin(100x), g. Leaf apex (40x), h. Leaf base (40x), h. Stem glandular projection (40x).

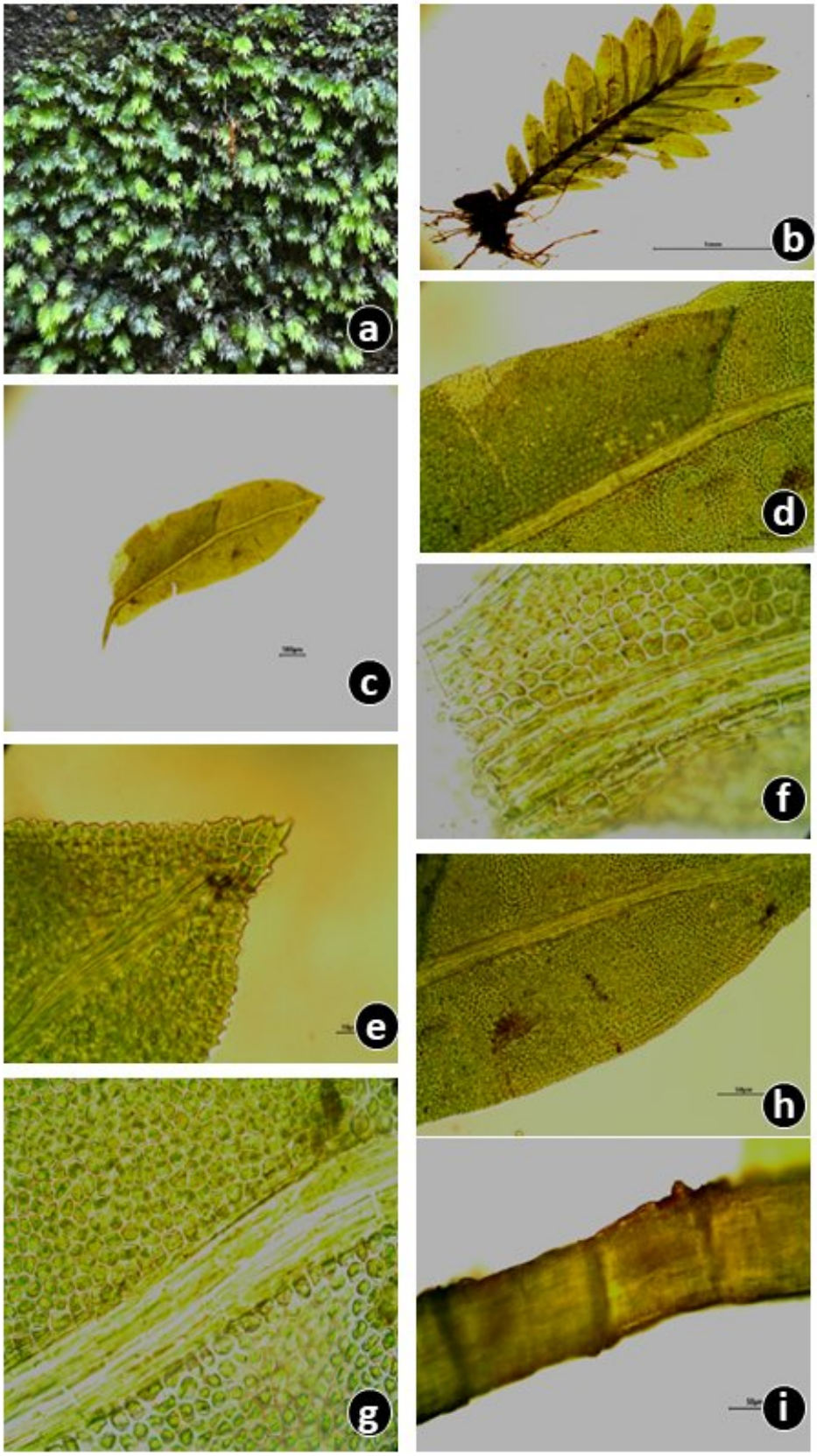


Plate 7. ***Fissidens walkeri*** **Broth (CF)**, a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Sheathing lamina (40x), e. Leaf apex (100x), f. Dorsal lamina base, g. Cell(100x), h. Leaf margin (40x), i. Stem glandular projection (40x).

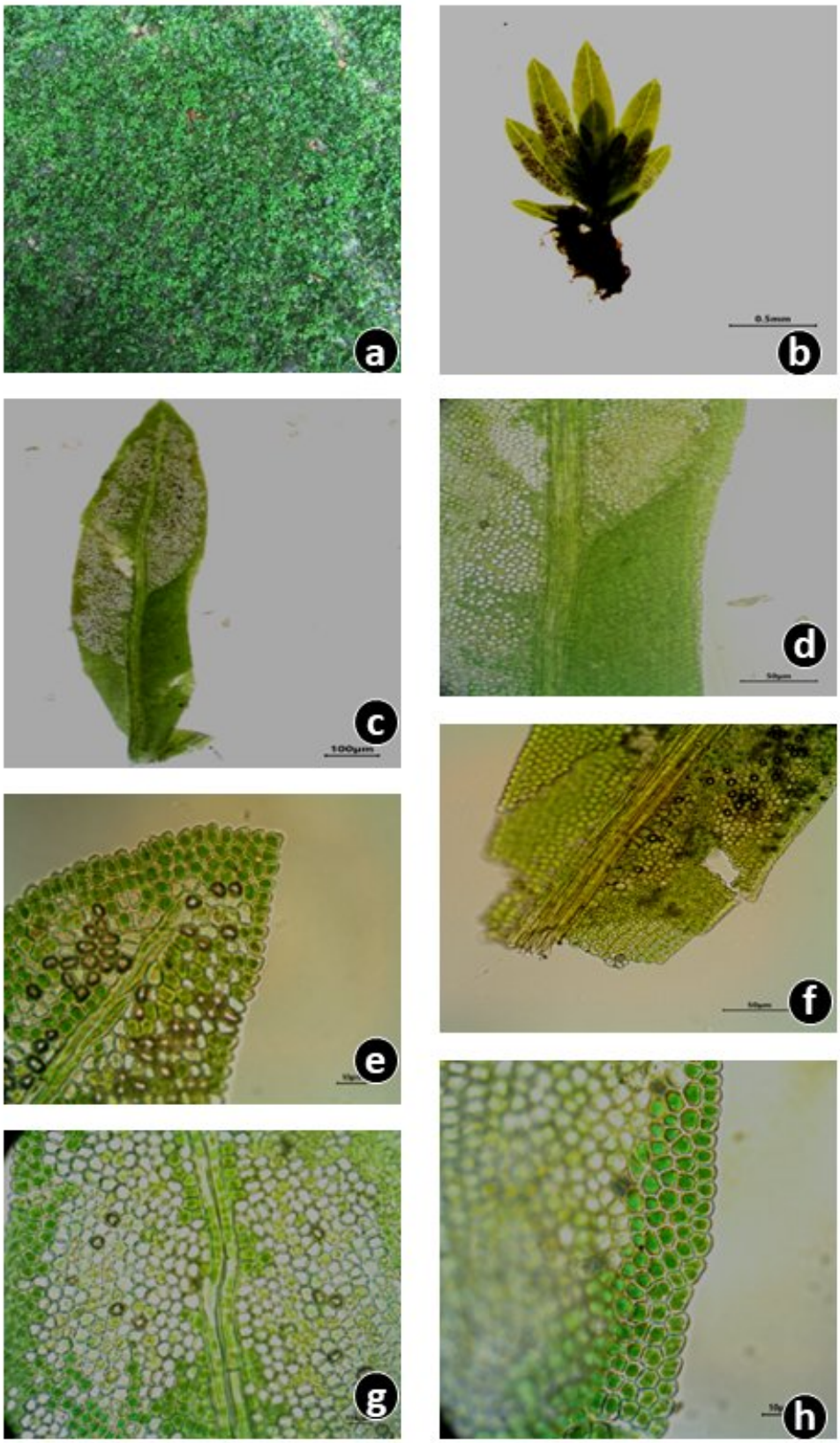


Plate 8. ***Fissidens sp. 1***, a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Sheathing lamina (40x), e. Leaf apex (100x), f. Dorsal lamina base, g. Cell (100x), h. Leaf margin (40x).

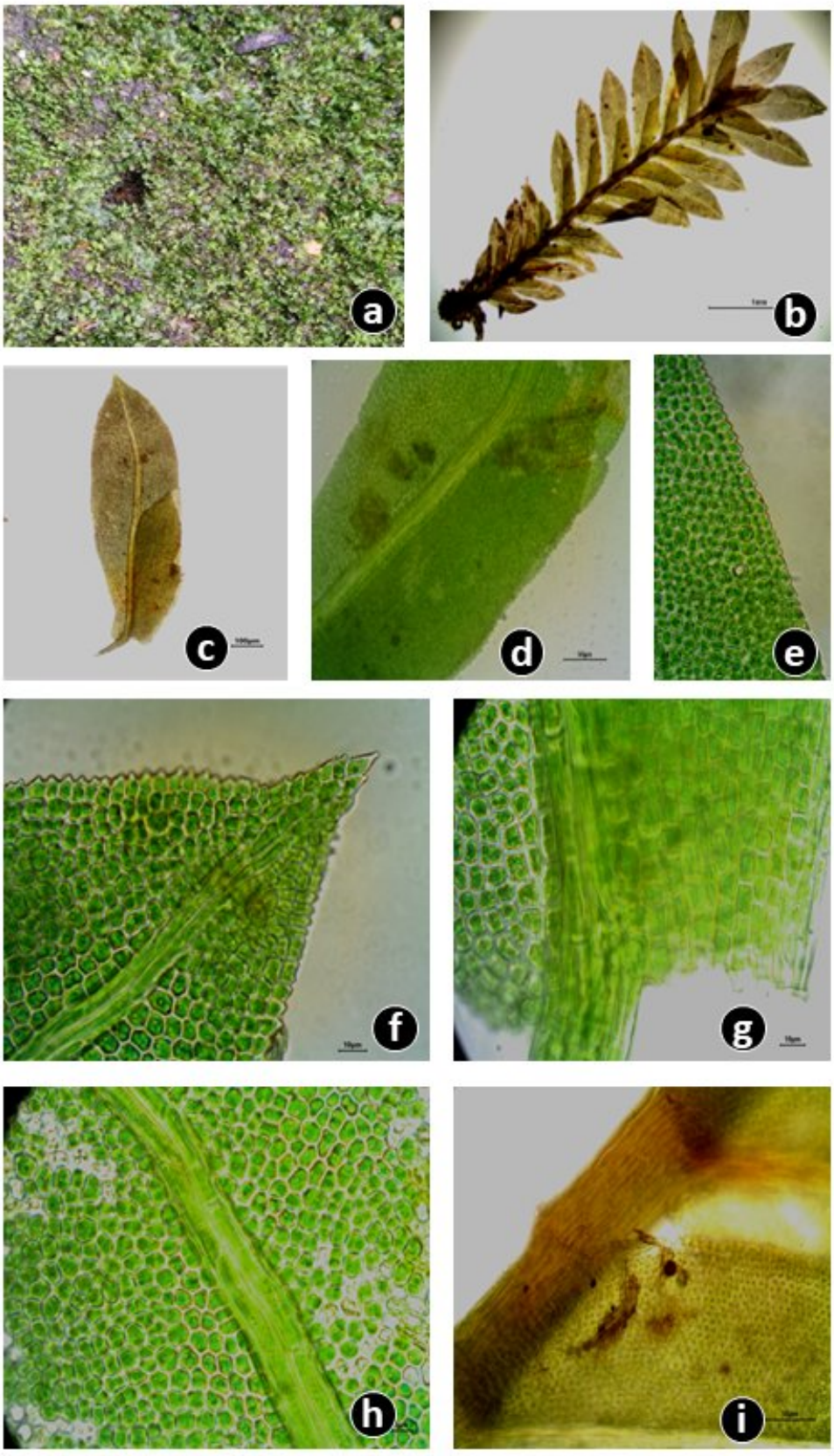


Plate 9. ***Fissidens sp. 2***, a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Sheathing lamina (40x), e. Leaf margin (100x), f. Leaf apex (100x), g. Dorsal lamina base, h. Cell(100x), i. Stem glandular projection (40x).

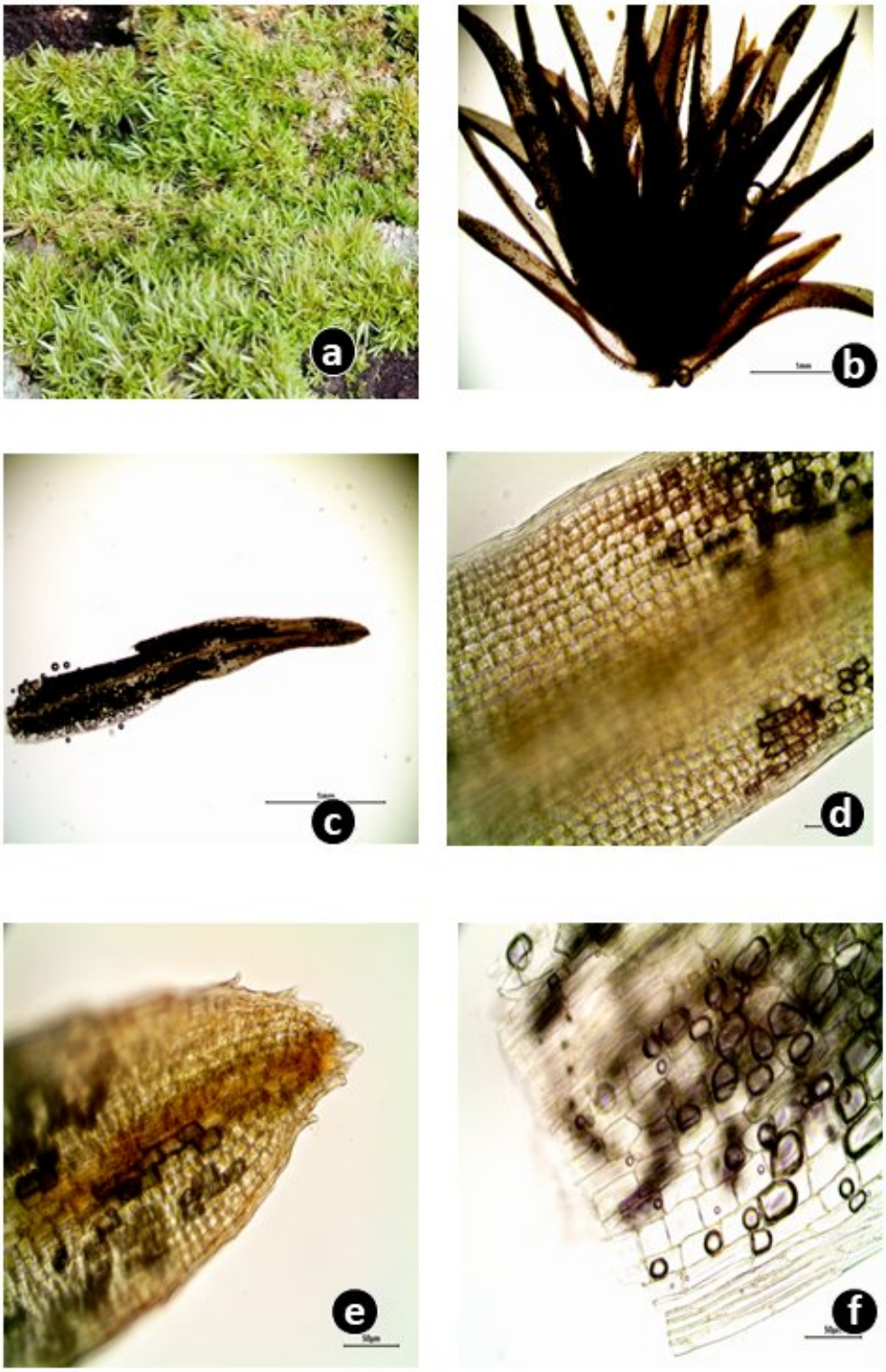


Plate 10. ***Lecophanes octoblepharioides*** **Brid**., a. Habit, b. Single plant (4x), c. Single leaf (4x), d. Leaf cells(40x), e. Leaf apex (40x), f. Leaf base(40x).

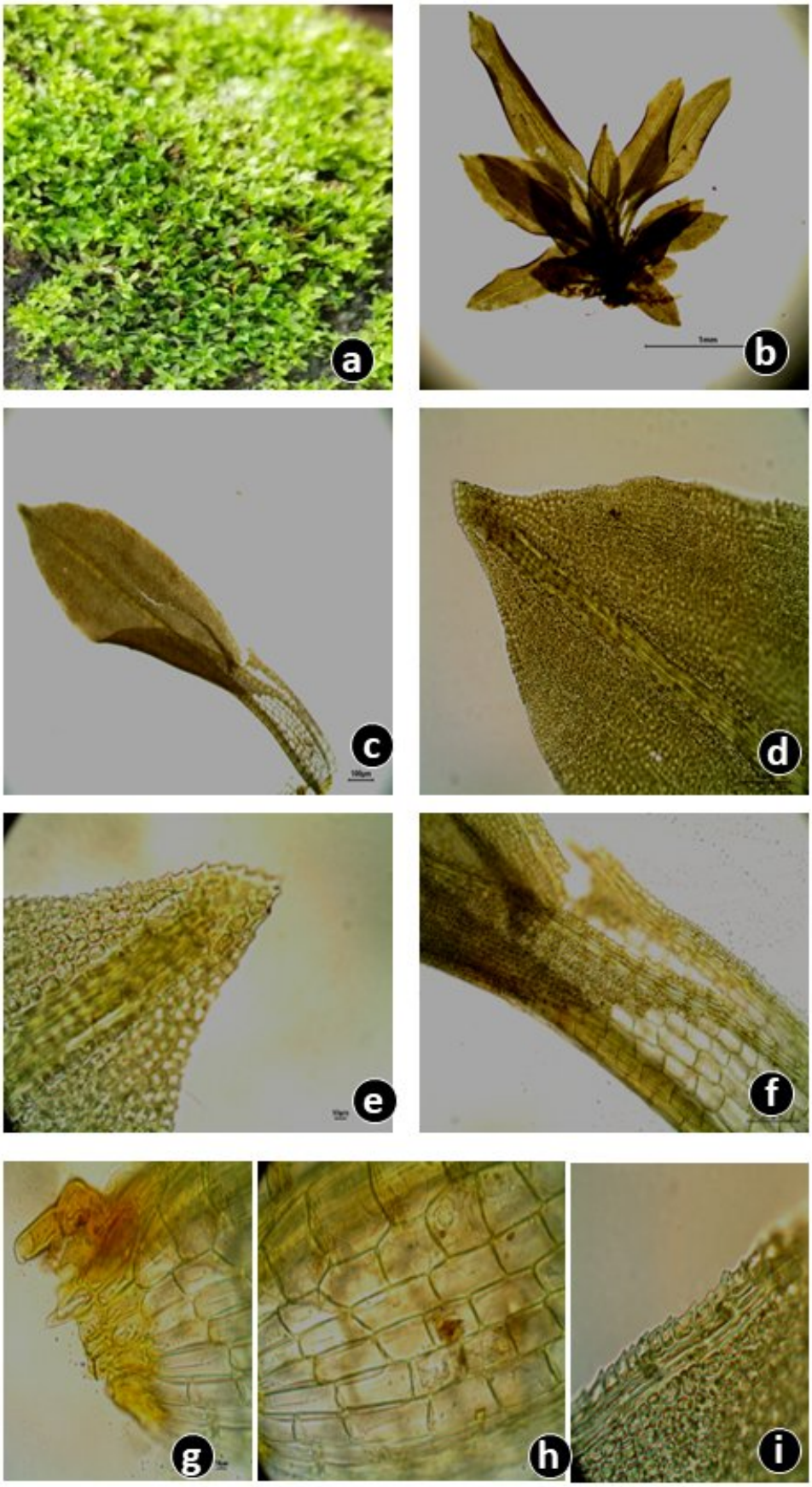


Plate 11. ***Calymperes erosum*** **Mull**., a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Leaf apex (40x), e. Leaf apex (100x), f. Leaf cells and basal cell (40x), g. Basal cells, h. Basal cells enlarged(100x), i. Leaf margin (100x).

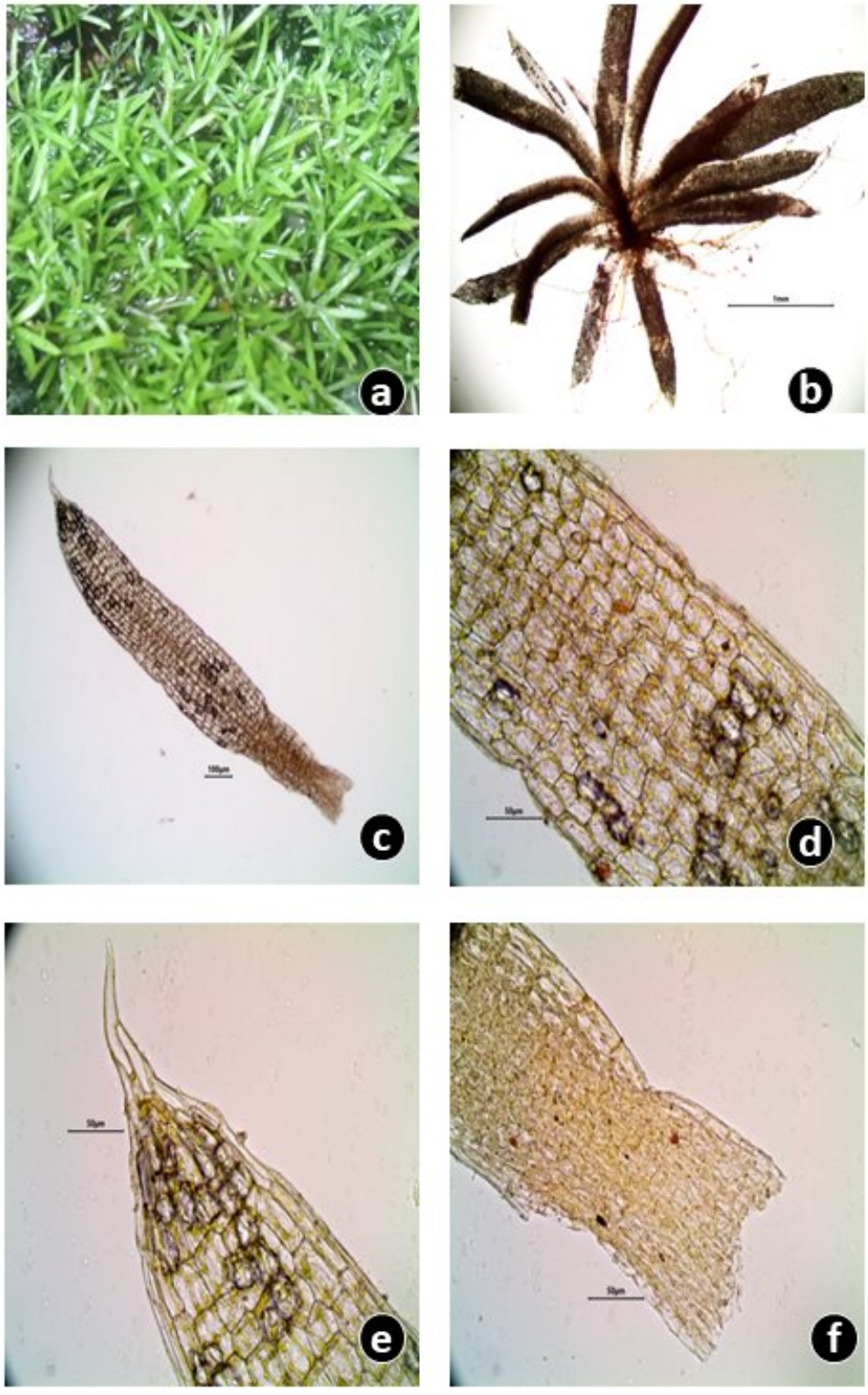


Plate 12. ***Octoblepharum albidum*** **Hedw**., a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Leaf cells (40x), e. Leaf apex (40x), f. Leaf base (40x).

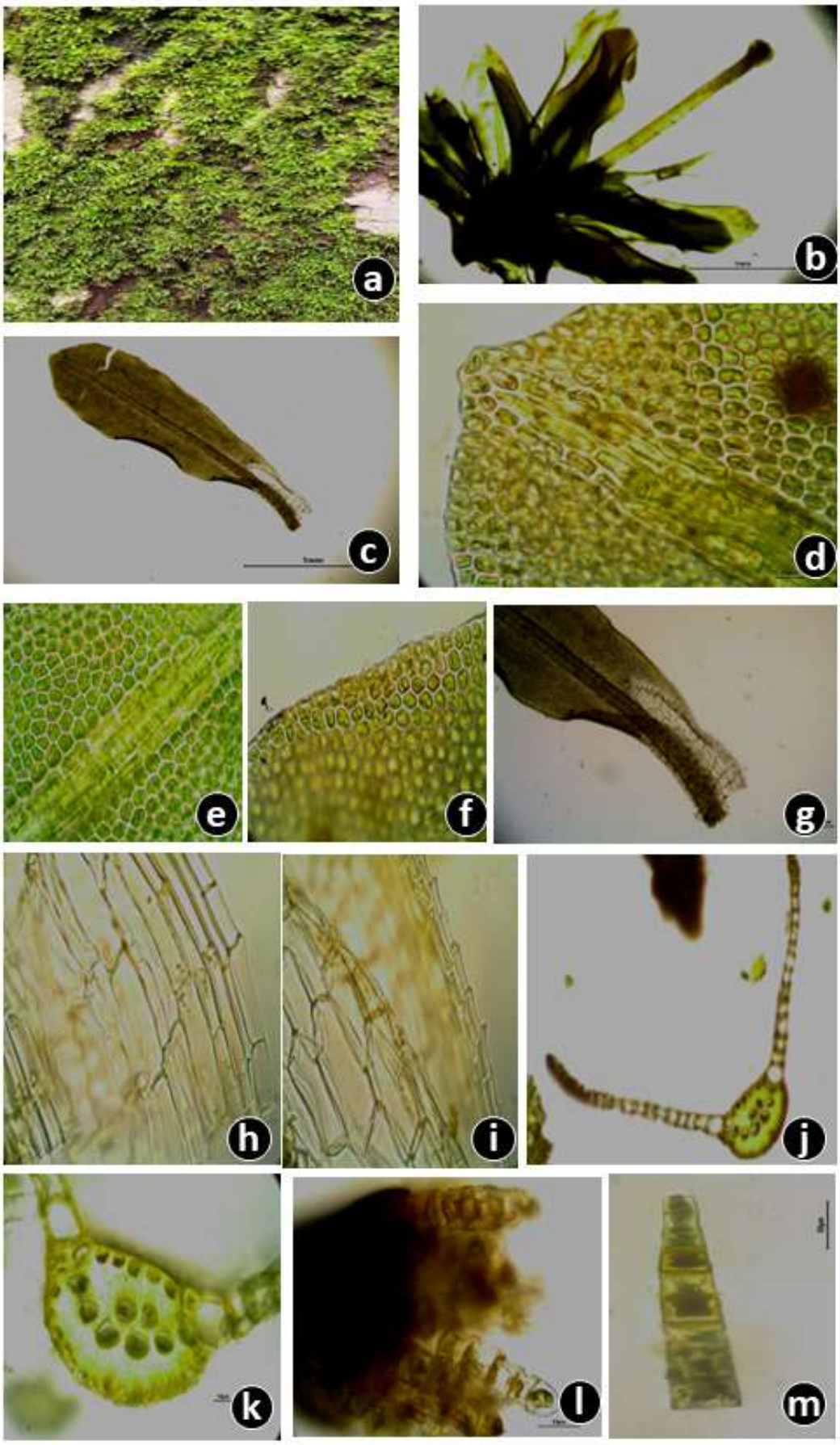


Plate 13. ***Chameleion peguense*** **(Besch.) L.T. Eills & Eddy**., a. Habit, b. Single plant (4x), c. Single leaf (4x), d. Leaf apex (100x), e. Cell (100x), f. Leaf margin (, (100x), g. Leaf base (40x), h. Hyaline cells(100x), i. Hyaline margin (100x), j. C.S of leaf (10x), k. C.S of leaf (100x), 1. Cluster of gemmae (100x), m. Single mature gemmae (100x).

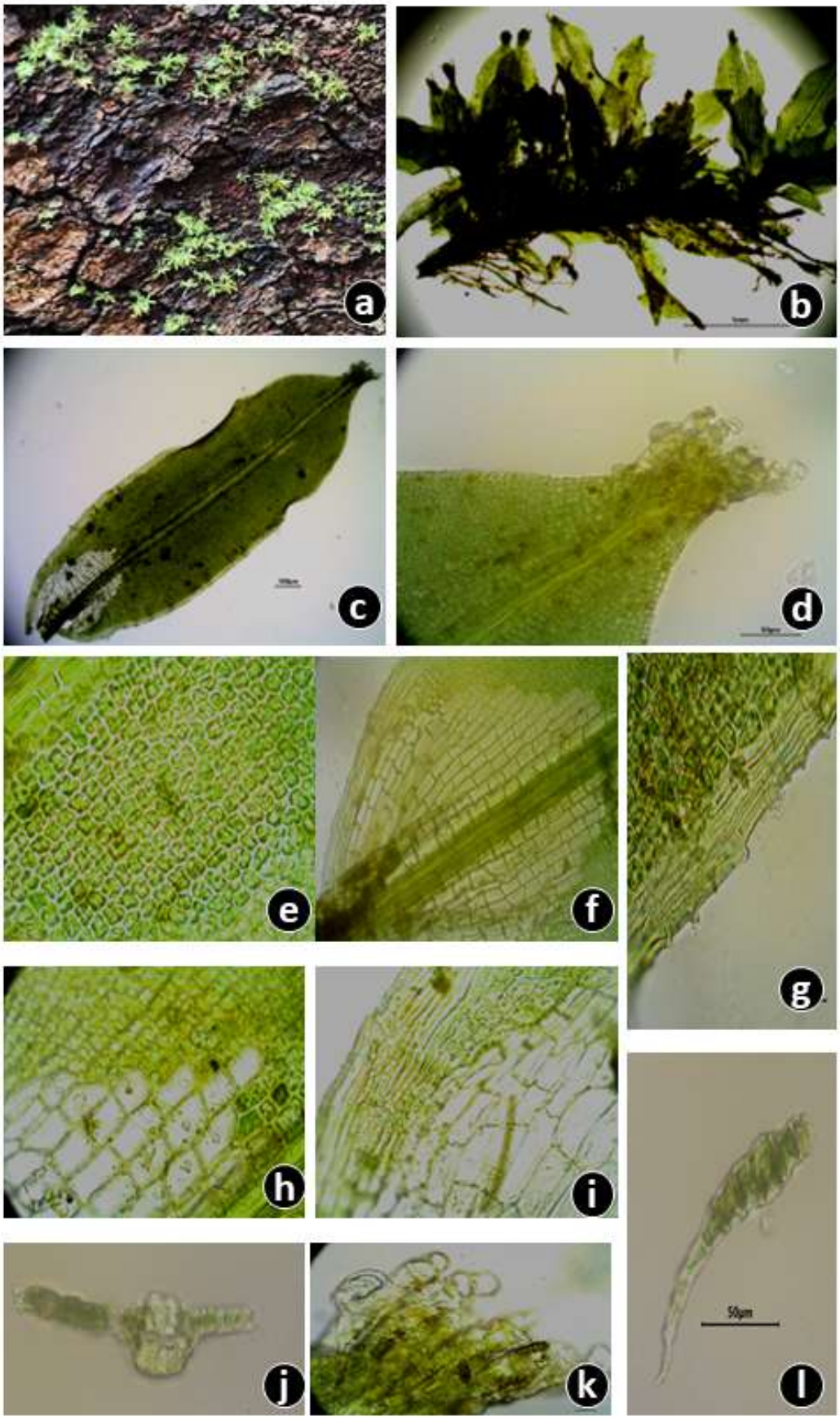


Plate 14. ***Thyridium cardotii*** **Fleisch. in Musci FI. Buitenz**. a. Habit, b. Single plant (4x), c. Single leaf (4x), d. Leaf apex (100x), e. Cell (100x), f. Leaf base (, (100x), g. Hyaline border (40x), h&i. Hyaline cells(100x), j. C.S of leaf (10x), k. Cluster of gemmae (100x), m. Single mature gemmae (100x).

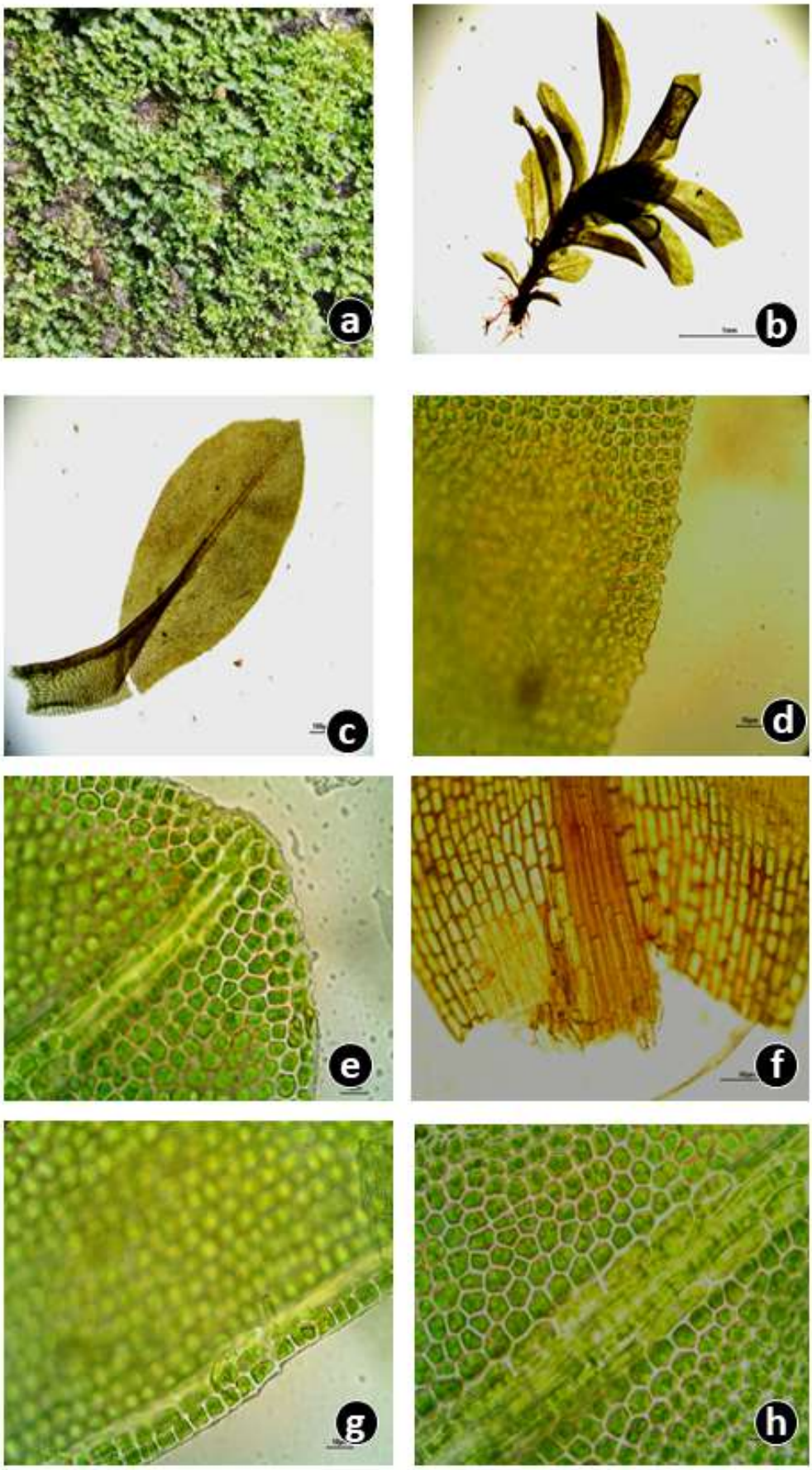


Plate 15. ***Hyophila involuta*** **Hook**, a. Habit, b. Single plant (4x) , c. Single leaf (10x), d. Leaf margin (100x), e. Leaf apex (100x), f . Leaf base(40x), g. Leaf margin (100x), h. Leaf cells(100x).

Plate 16. ***Philonotis hastata*** **(Duby) Wijk & Margad**., a. Habit, b. Single plant (4x), c. Single leaf (10x), d. Leaf apex (100x), e. Leaf base (40x), f. Cells enlarged (100x), g. Leaf margin (100x).

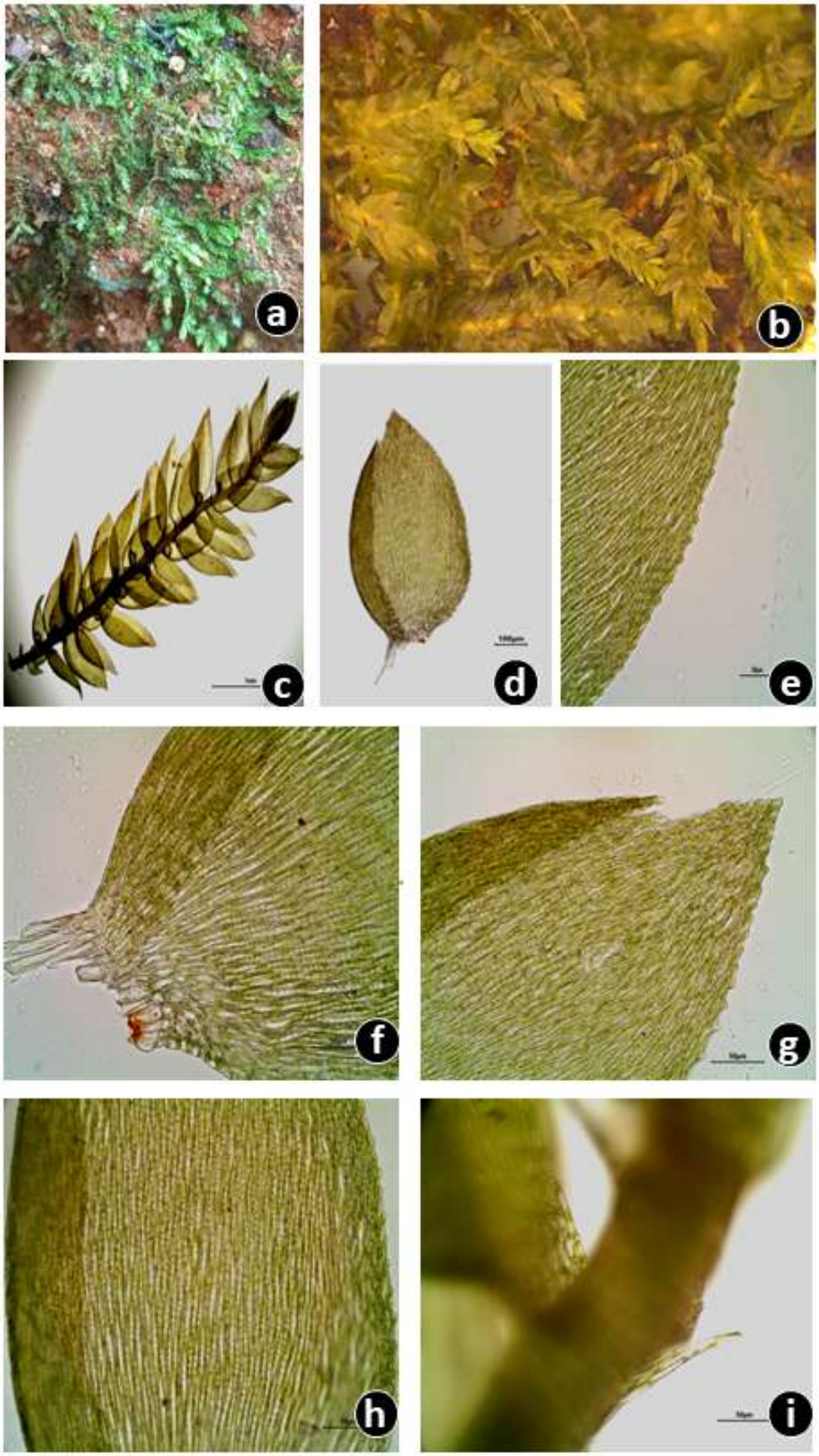


Plate 16. ***Sematophyllum caespitosum*** **(Hedw.) Mitt.**, a&b. Habit, c. Single plant (4x), d. Single leaf (10x), e. Leaf margin (40x), f. Leaf base (40x), g. Leaf apex (40x), h. Leaf cells (40x), i. Stem glandular projection (40x).

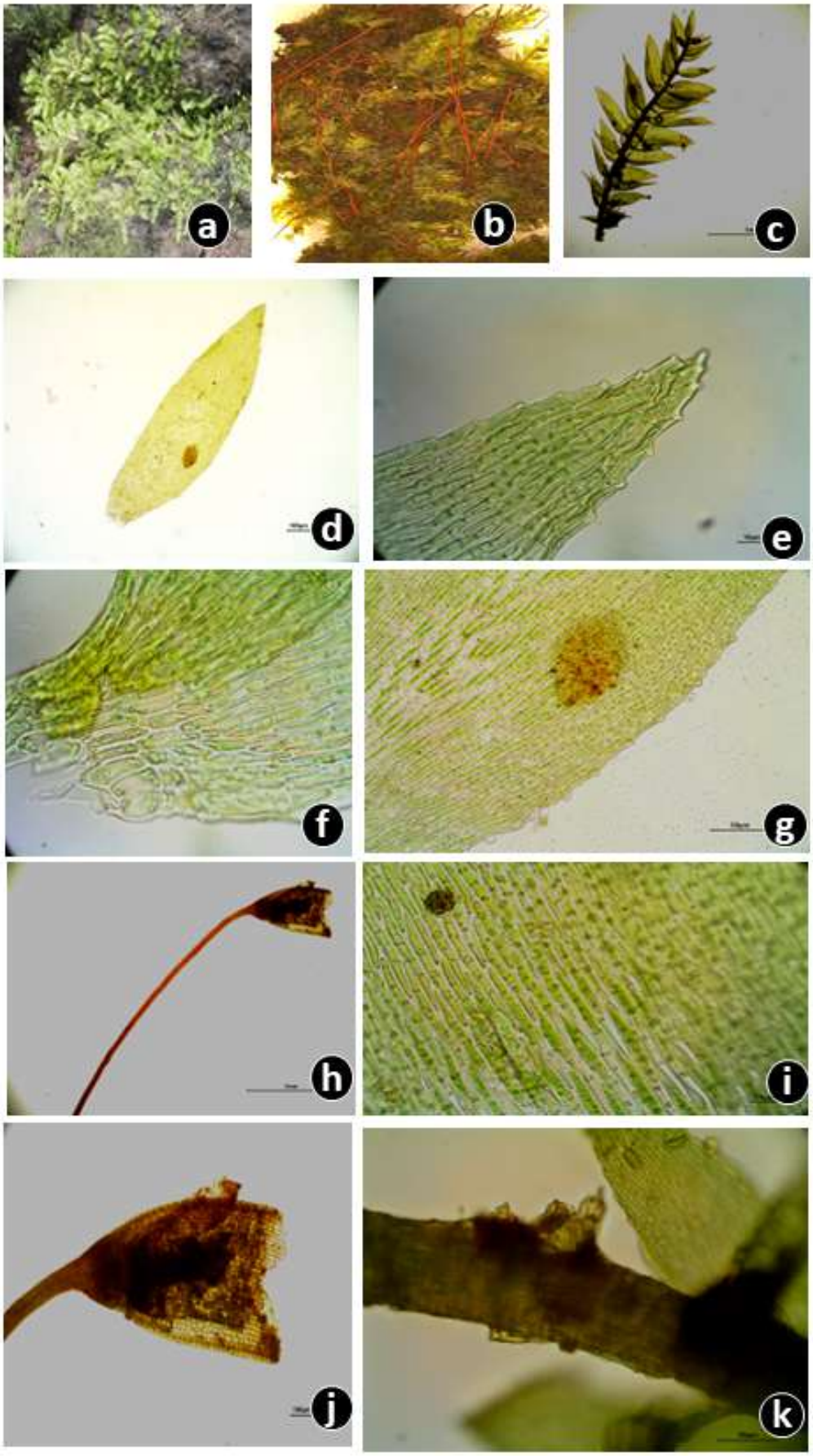


Plate 17. ***Sematophyllum subhumile*** **(Mull. Hal.) M.Fleisch**, a&b Habit, c. Single plant (4x), d. Single leaf (10x), e. Leaf apex (`100x), f. Leaf base (100x), g. Leaf margin (40x), h. Sporophyte (4x), i. Cells enlarged (100x), j. Capsule (10x), k. Stem glandular projection (40x).

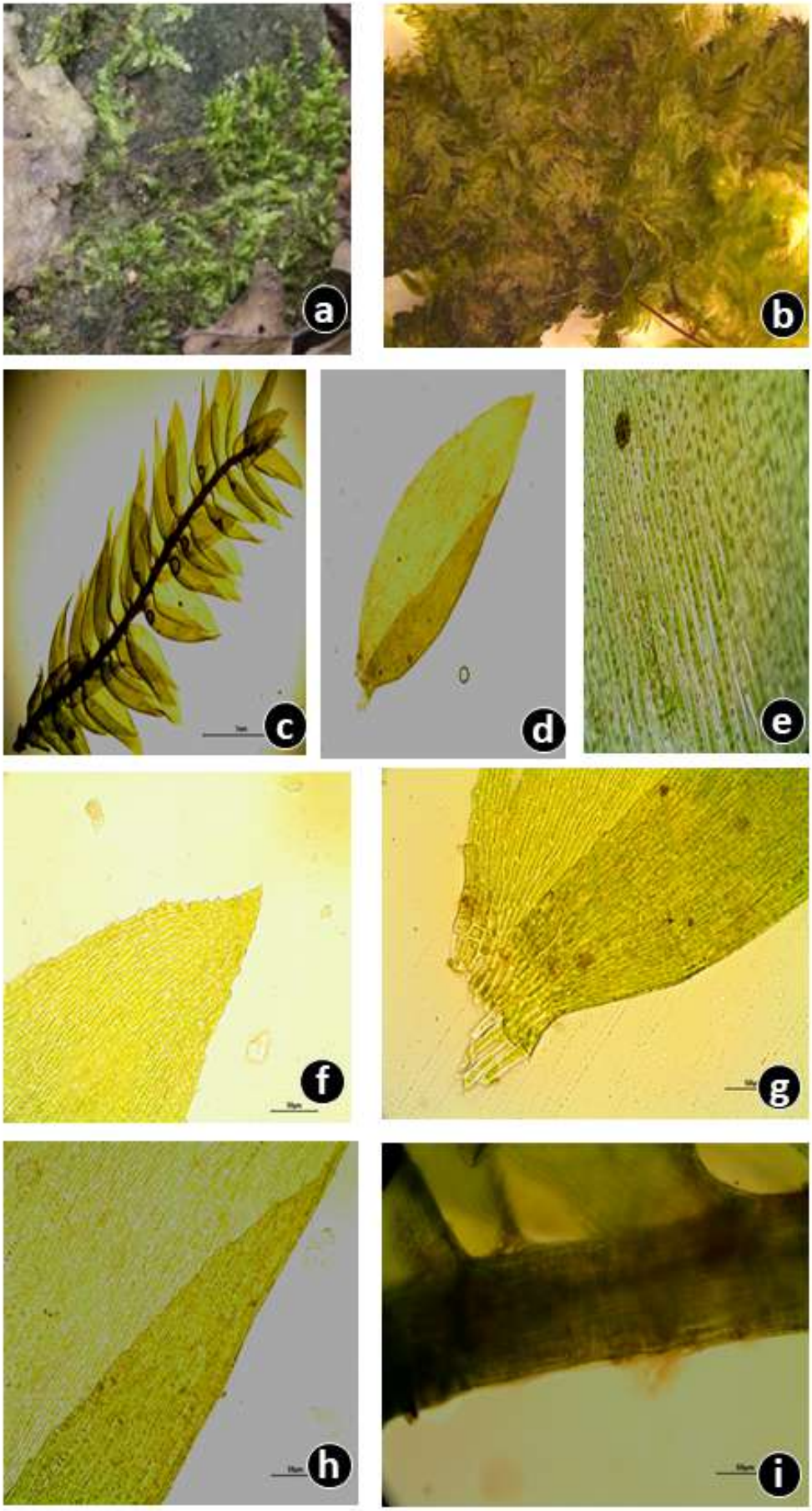


Plate 18. ***Taxithelium nepalense*** **(Schwagr.) Broth**.,a & b. Habit, c. Single plant (4x), d. Single leaf (10x), e. Leaf cells (40x), f. Leaf apex (40x), g. Leaf base (40x), h. Leaf margin (40x), i. Stem glandular projection (40x).

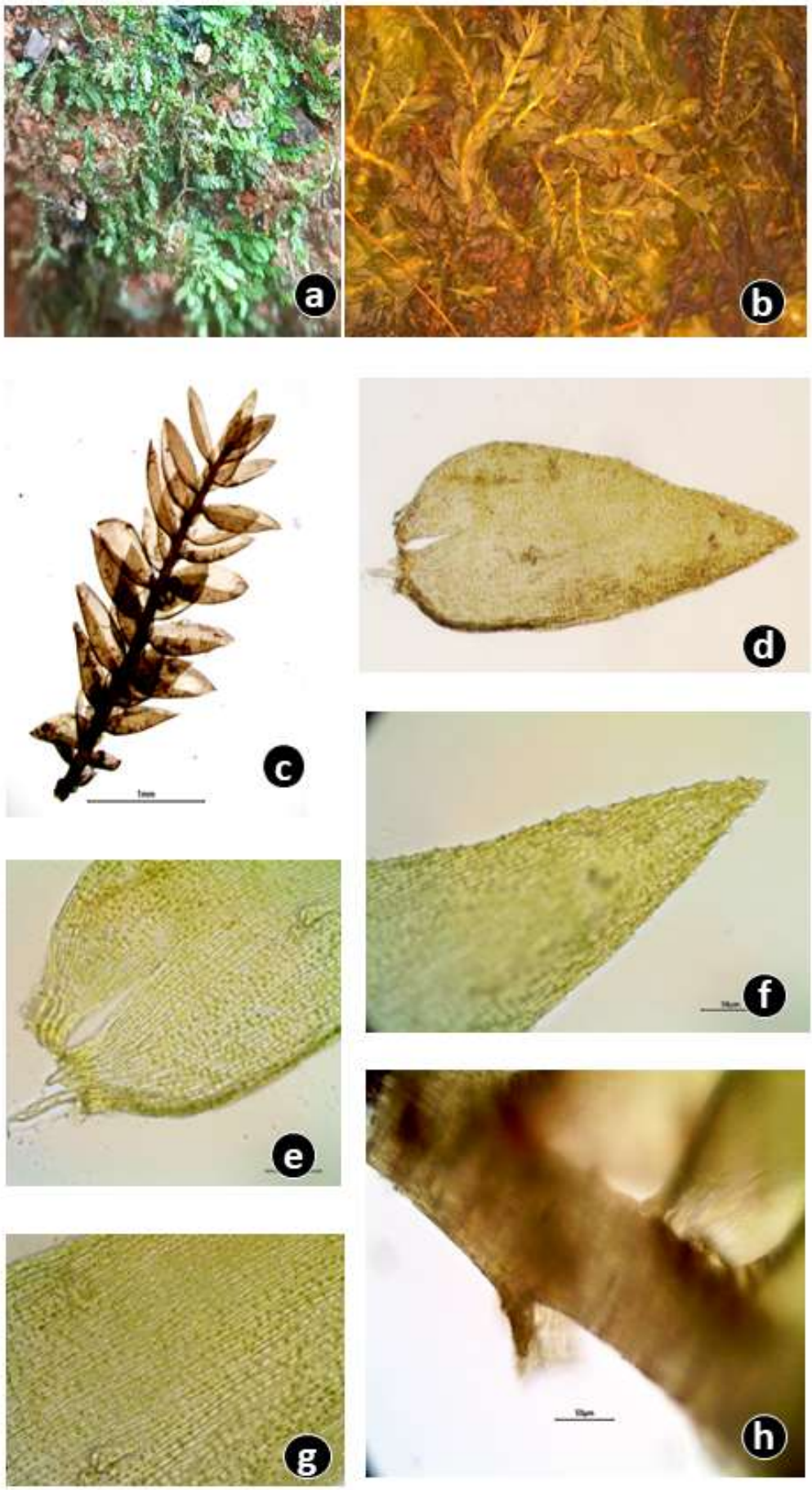


Plate 19. ***Taxithelium sp***. a &b Habit, c. Single plant (4x), d. Single leaf (10x), e. Leaf base (40x), f. Leaf apex (40x), g. Leaf cells (40x), h. Stem glandular projection (40x).

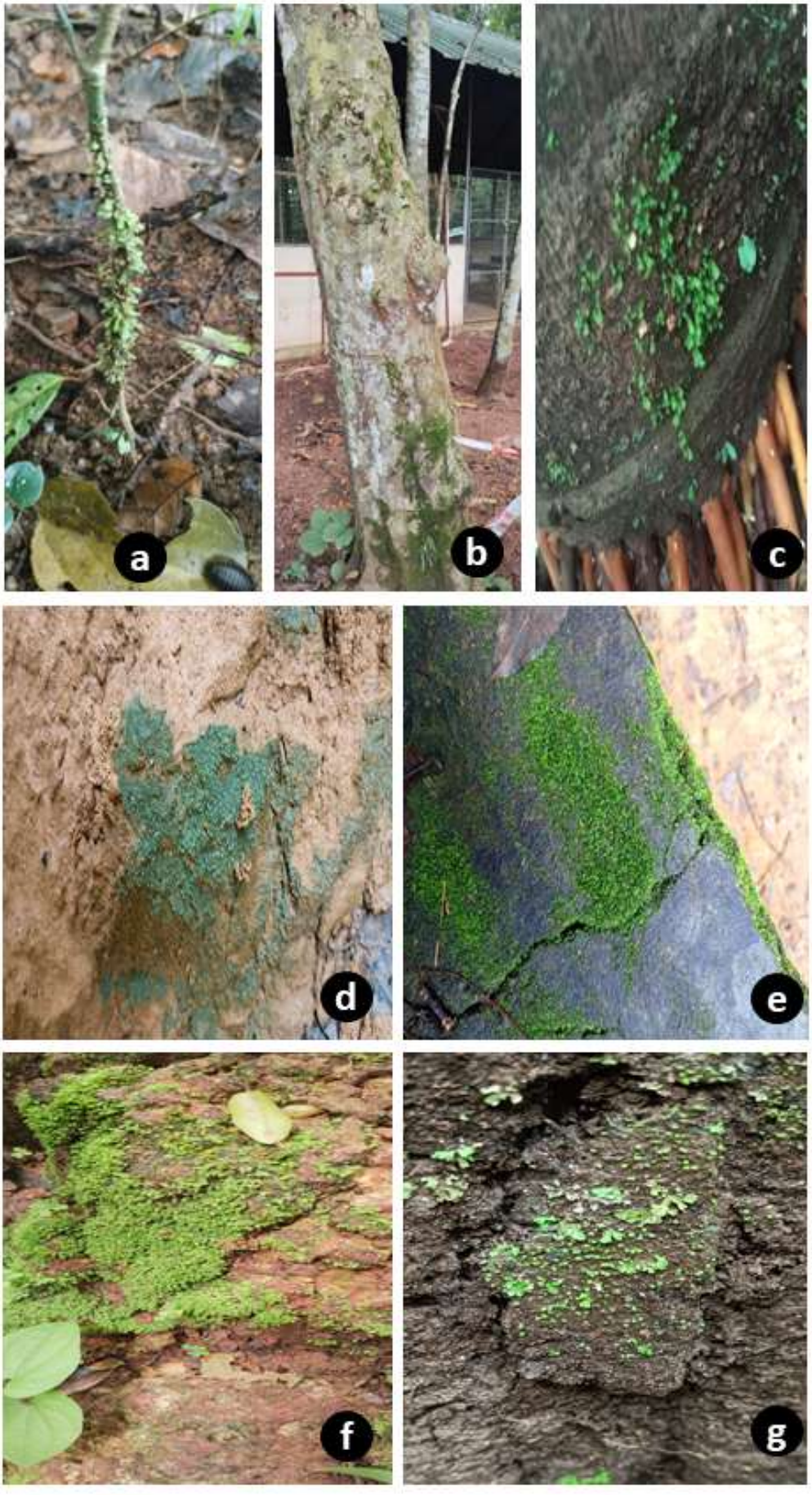


Plate 21. Different microhabit of Bryophytes; a. Young stem of plant, b. Tree, c. Palm tree, d. Termite mount, e. Concrete wall, f. Land cutting, g. Friable rock.

Plate 22. Different microhabit of Bryophytes; a & b. Rock, c & d. Rotten log

Plate 2. a – i : Different Macrohabits of Iringole Kavu

Plate 23. a – e: Various types of pollutants found .

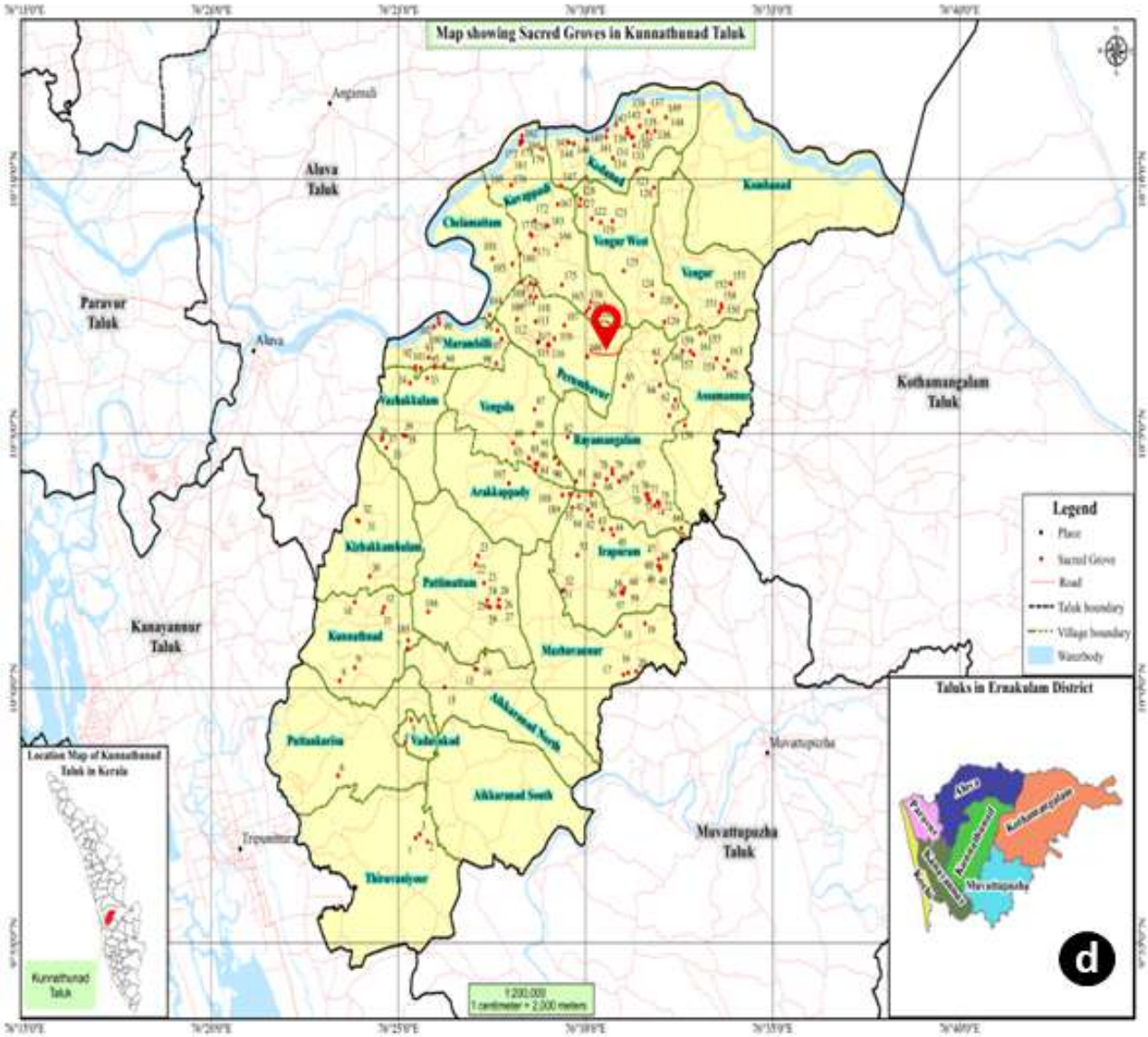


Plate 1. Study area; a,b&c: Iringole Kavu, d: Map of Study Area

Photo courtesy : Chandrashekara, U.M., 2011

REFERENCES

Ahmed, M., Dar, G. H., Rashid, I., & Khuroo, A. A. (2023). Sacred groves: The gene banks of threatened and ethnomedicinal flora, associated taboos and role in biodiversity conservation in the Peer Panchal range of North Western Himalayas, India. *Ecological Questions, 34*(3), 1–20.

Allendorf, T. D., Brandt, J. S., & Yang, J. M. (2014). Local perceptions of Tibetan village sacred forests in northwest Yunnan. *Biological Conservation, 169*, 303–310.

Benítez, Á., Espinosa, C. I., Ríos-Touma, B., & Ron, S. R. (2025). Bryophytes as indicators of disturbance in one of the last remnants of the mountain forests of El Oro Province, Ecuador. *Plants, 14*(184

Bhagwat, S. A., & Rutte, C. (2006). Sacred groves: Potential for biodiversity management. *Frontiers in Ecology and the Environment, 4*(10), 519–524

Bhagwat, S. A., Kushalappa, C. G., Williams, P. H., & Brown, N. D. (2005). A landscape approach to biodiversity conservation of sacred groves in the Western Ghats of India. *Conservation Biology, 19*(6), 1853–1862

Brummitt, R. K., & Powell, C. E. (1992). *Authors of plant names*. Royal Botanic Gardens, Kew.

Chanda, S., & Ramachandra, T. V. (2019). Vegetation in the sacred groves across India: A review. *Research & Reviews Journal of Ecology, 8*, 29–38.

Chandrakanth, M. G., Bhat, M. G., & Accavva, M. S. (2004). Socio-economic changes and sacred groves in South India: Protecting a community-based resource management institution. *Natural Resources Forum, 28*(2), 102–111.

Chandran, M. D. S., & Gadgil, M. (1993). Kans-safety forests of Uttara Kannada. In *Proceedings of the IUFRO Forest History Group Meeting on Peasant Forestry* (pp. 49–57).

Chandran, M. D. S., & Hughes, J. D. (1997). The sacred groves of South India: Ecology, traditional communities and religious change. *Social Compass, 44*(3), 413–428.

Chandrashekara, U. M., & Sankar, S. (1998). Ecology and management of sacred groves in Kerala, India. *Forest Ecology and Management, 112*(1–2), 165–177.

Chandrashekara, U. M. (2011). *Conservation and management of sacred groves in Kerala*. Kerala Forest Research Institute (KFRI), Peechi, Kerala. (Project funded by the Biodiversity Cell, Department of Forests and Wildlife, Government of Kerala).

Churchill, S. P., & Linares, E. L. (1995). *Prodromus Bryologiae Novo-Granatensis: Introducción a la flora de musgos de Colombia* (Vol. 1). Instituto de Ciencias Naturales, Museo de Historia Natural.

Daniels, A. E. D., & Daniel, P. (2013). *The bryoflora of the southernmost Western Ghats, India*. Bishen Singh Mahendra Pal Singh.

Dandotiya, D., Govindapyari, H., Suman, S., & Uniyal, P. L. (2011). Checklist of the bryophytes of India. *Archive for Bryology, 88*.

Dhyani, A., Shantanu, K., Sharma, R. K., & Uniyal, P. L. (2024). Diversity of mosses (Bryophyta) in Pangi valley (Himachal Pradesh, India): An unexplored domain of northwestern Himalaya. *Journal of Threatened Taxa, 16*(5), 25227–25234.

Duan, C., & Wang, Y. (2023). Species diversity and microhabitat characteristics of bryophytes on different types of walls in a karst city (Guiyang, SW China). *Urban Ecosystems, 27*(3), 1–14.

Gadgil, M., & Vartak, V. D. (1975). Sacred groves of India: A plea for continued conservation. *Journal of the Bombay Natural History Society, 72*, 314–320.

Gangulee, H. C. (1969–1980). *Mosses of Eastern India and adjacent regions* (Vols. I–III, Fasc. 1–8). Botanical Survey of India.

Glime, J. M. (2007). *Bryophyte ecology. Volume 1: Physiological ecology*. Echan Publications. Retrieved from https://digitalcommons.mtu.edu/bryophyte-ecology/

Gokhale, Y. (2004). Reviving traditional forest management in Western Ghats: Study in Karnataka. *Economic and Political Weekly, 39*(39), 3556–3559.

Gradstein, S. R., Churchill, S. P., & Salazar-Allen, N. (2001). *Guide to the bryophytes of tropical America*. Missouri Botanical Garden Press.

Jyothilakshmi, G. R., Manju, C. N., Venugopal, M., & Chandini, V. K. (2016). Bryophyte diversity in the sacred groves, with special reference to Vallikkattukavu of Kozhikode district in Western Ghats. *Plant Science Today, 3*(2), 135–141.

Kassilly, F. N., & Tsingalia, H. M. (2009). Persistence and loss of cultural values of Tiriki sacred groves in Hamisi District, Kenya: Implications for management. *Journal of Human Ecology, 27*(2), 137–144.

Kassilly, F. N. (2023). Threats to the survival of Tiriki sacred groves in Kenya: A cultural perspective. *Journal of Culture, Society and Development, 24*, [Article ID pending]. ISSN 2422-8400.

Kent, E. (2009). Sacred groves and local gods: Religion and environmentalism in South India. *Worldviews: Global Religions, Culture, and Ecology*, *13*(1), 1–39.

Khan, M. L., Khumbongmayum, A. D., & Tripathi, R. S. (2008). The sacred groves and their significance in conserving biodiversity—An overview. *International Journal of Ecology and Environmental Sciences, 34*(3), 277–291.

Khumbongmayum, A. D., Khan, M. L., & Tripathi, R. S. (2004). Sacred groves of Manipur—Ideal centres for biodiversity conservation. *Current Science*, *87*(4), 430–433.

Kolavalli, S. (1997). Joint forest management: Optimal property rights? In A. Agarwal (Ed.), *The challenge of the balance: Environmental economics in India* (pp. 235–242). Centre for Science and Environment.

Kerala State Council for Science Technology and Environment. (2005). *State of environment report Kerala*. ENVIS Centre, Thiruvananthapuram.

Madhusoodanan, P. V., & Nair, M. C. (2003). *Ricciocarpus natans* (L.) Corda (Ricciaceae) and *Notothylas levieri* Schiffn. ex Steph. (Notothylaceae), two new bryophyte records for South India. *Indian Journal of Forestry*, *26*(3), 295–298.

Malhotra, K. C., Gokhale, Y., Chatterjee, S., & Srivastava, S. (2007). *Sacred groves in India*. Aryan Books International.

Manju, C. N., Rajesh, K. P., & Madhusoodanan, P. V. (2008). *Fissidens kammadensis* (Fissidentaceae: Bryopsida), a new species of moss from a sacred grove in Peninsular India. *Acta Botanica Hungarica*, *50*(1–2), 159–162.

Manju, C. N., & Rajesh, K. P. (2011). Contribution to the bryophyte flora of India: The Parambikulam Tiger Reserve in the Western Ghats. *Archive for Bryology, 42*, 1–10.

Manju, C. N., & Rajesh, K. P. (2011). *Grimmia funalis* (Schwägr.) Bruch & Schimp. (Grimmiaceae) from India. *Taiwania, 55*(2), 81–83.

Manju, C. N., Rajesh, K. P., & Madhusoodanan, P. V. (2009). Contribution to the bryophyte flora of India: The Aralam Wildlife Sanctuary in the Western Ghats. *Archive for Bryology, 42*, [pages missing].

Manju, C. N., Rajesh, K. P., & Madhusoodanan, P. V. (2009). *Jungermannia obliquifolia* (Schiffn.) Vána (Marchantiophyta) from India. *Bangladesh Journal of Plant Taxonomy, 16*(1), 95–97.

Manju, C. N., Rajesh, K. P., Jitha, S., Reshma, P. K., & Prakashkumar, R. (2011). Bryophyte diversity of Kakkavayal Reserve Forest in the Western Ghats of India. [Journal name and details incomplete].

Mufeed, B., Nair, M. C., & Rajesh, K. P. (2021). *Bryophytes of Anamudi Shola National Park in the Western Ghats of Kerala, India*. Centre for Research in Indigenous Knowledge, Science & Culture (CRIKSC).

Nagendra, H., & Gokhale, Y. (2008). Management regimes, property rights, and forest biodiversity in Nepal and India. *Environmental Management, 41*(5), 719–733.

Nair, M. C., & Madhusoodanan, P. V. (2001). Contribution to the bryophyte flora of Eravikulam National Park, Kerala. *Journal of Economic and Taxonomic Botany, 25*, 569–574.

Nair, M. C., Chandini, V. K., & Rajesh, K. P. (2020). An overview of the family Calymperaceae (Bryophyta) in Western Ghats with special reference to Kerala and its status in India. *Contemporary Research on Bryophytes, 1*, 52–80.

Nair, M. C., Rajesh, K. P., & Madhusoodanan, P. V. (2005). *Bryophytes of Wayanad in Western Ghats*. Malabar Natural History Society, Calicut.

Nair, M. C., Rajesh, K. P., & Madhusoodanan, P. V. (2004). *Bryum tuberosum* Mohamed & Damanhuri, a new record for India. *Indian Journal of Forestry, 27*(1), 39–40.

Nair, M. C., Rajesh, K. P., & Madhusoodanan, P. V. (2007). Three new bryophyte records for Peninsular India. [Publication details missing].

Neethu, P., & Sreeja, P. (2020). Comparative study of bryoflora from selected sacred groves of Kannur, Kerala, India. *International Journal of Creative Research Thoughts, 8*, 4279–4285.

Nishida, P. P., Manju, C. N., & Rajesh, K. P. (2022). A review: Sacred groves and their bryophyte studies. *Tropical Plant Research, 9*(1), 49–54.

Ormsby, A. (2011). The impacts of global and national policy on the management and conservation of sacred groves of India. *Human Ecology, 39*(6), 783–793.

Plieninger, T., Quintas-Soriano, C., Torralba, M., Samani, K. M., & Shakeri, Z. (2020). Social dynamics of values, taboos, and perceived threats around sacred groves in Kurdistan, Iran. *People and Nature, 2*, 1237–1250.

Poffenberger, M., & McGean, B. (Eds.). (1996). *Village voices, forest choices*. Oxford University Press.

Schaaf, T., & Rössler, M. (2010). Sacred natural sites, cultural landscapes and UNESCO's action. In B. Verschuuren, R. Wild, J. A. McNeely, & G. Oviedo (Eds.), *Sacred natural sites: Conserving nature & culture* (pp. 161–169). Earthscan.

Shaw, A. J., & Goffinet, B. (2000). *Bryophyte biology*. Cambridge University Press.

Singh, H., Husain, T., & Agnihotri, P. (2010). Haat Kali sacred grove, Central Himalaya, Uttarakhand. *Current Science, 98*(2), 290.

Singh, A. P., & Nath, V. (2007). *Hepaticae of Khasia and Jaintia Hills, Eastern Himalayas* (p. 382). Bishen Singh Mahendra Pal Singh.

Srivastava, S. C., & Alam, A. F. (2004). *Frullania riojanerensis* (Raddi) Spruce—An addition to Indian bryoflora. *Geophytology, 33*(1–2), 47–51.

Tiwari, B. K., Barik, S. K., & Tripathi, R. S. (1995). *Sacred groves of Meghalaya: Status and strategies for their conservation*. North-Eastern Hill University.

Wild, R., & McLeod, C. (2008). *Sacred natural sites: Guidelines for protected area managers*. IUCN.